VOLUME XLII NUMBER 4 WHOLE 366

SCHOOL SCIENCE AND MATHEMATICS

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APRIL 1942

School Science and Mathematics

A Journal for All Science and Mathematics Teachers

Entered as second class matter December 8, 1932, at Menasha, Wisconsin, under the Act of March 3, 1879. Published Monthly except July, August and September at 450 Ahnaip St., Menasha, Wis.

PRICE. Two Dollars and Fifty Cents a year; foreign countries $3.00; current single copies 35 cents.

Contents of previous issues may be found in the Educational Index to Periodicals.

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SCHOOL SCIENCE AND MATHEMATICS

VOL. XLII APRIL, 1942 WHOLE NO. 366

1941: A RECORD YEAR IN SHIPPING ON THE GREAT LAKES

VILLA B. SMITH

John Hay High School, Cleveland, Ohio

On April 4th, 1941 the *Marquette* opened navigation at Escanaba and on the 9th brought its cargo of iron ore into the port of Cleveland. It was accompanied by its sister ship, the *Joliet.* Early April found Green Bay with two feet of ice, the waters above Detroit blocked with ten foot piles of drift ice and Lake Erie ice covered. On April 7th the *Cadillac* left the ice choked harbor of Marquette with the season's first cargo of ore from a Lake Superior port. On the 8th, the 9th and the 11th of April navigation opened in the ports of Duluth-Superior, Two Harbors and Ashland respectively. The 1941 season was under way earlier than at any time in twenty-five previous years. The early April ore shipments ushered in the greatest shipping season the Great Lakes had ever experienced. Until mid-December freighters plied the inland waters establishing an all-time high for commodities moving both up and down the lakes.

Weather is the key to Great Lakes shipping. Wind, rain, fog, ice, snow and cold are factors to be reckoned with. By November 9th freezing temperatures were affecting the speed of loading at upper lake ports. On that date frozen ore was steamed at the Duluth-Superior docks. On days that followed, fires in storage yards and heating plants at docks kept ore moving. On December 8th the last ore cargo of the season left Duluth in the *Bethlehem.* On December 2d the port of Ashland dispatched its last ore cargo. On December 7th Marquette sent its last.

On December 11th, with temperature 7° below zero, the

Venus reached Duluth-Superior. Ice was three to four inches thick in the harbor. The *Venus* experienced high winds in Lake Superior and arrived ice covered. It was necessary to break the ice in the slip before the vessel could be loaded with scrap iron for a lower lake port. December 12th, the *James Watt* reached Duluth in a snow storm. It brought a load of automobiles from Detroit. The *Watt* loaded grain for Buffalo. Its departure closed the port for the season.

Late season trips on the Great Lakes are hazardous. The Pittsburgh Steamship Company, with the largest fleet on the lakes, sent no vessels to the upper lakes after December 1st. After that date it used some of its boats to carry limestone to Lake Erie ports. Other companies sent vessels to the upper lakes for one cargo after December 1st. As the season advances and weather becomes more uncertain, insurance rates on vessels and cargoes increase. All regular insurance rates expire at midnight, November 30th. Insurance at a slightly higher rate can be obtained until midnight, December 5th. Insurance at a still higher rate is issued until midnight, December 12th. Insurance after December 12th is special.

Canal service on the Great Lakes-St. Lawrence waterway also reflects weather and shipping conditions. The Welland Ship Canal closed at midnight December 12th. The Canadian lock at Sault Ste Marie closed at midnight December 10th. The American locks remained open until December 14th to accommodate late vessels. Anticipating the late closing date and probable difficulties with ice, the Coast Guard cutter, *Tahoma*, was shifted from Cleveland to Sault Ste Marie in late October to serve as an ice breaker.

The 1941 season at the Soo totaled 166 days, seven days less than the 1902 season which was the longest on record. During October 1941, the collapse of the bridge at Sault Ste Marie interfered with traffic through two of the locks and it is estimated cut some 500,000 tons of ore from the October total. The 1941 tonnage at the Soo established an all-time high, totalling 111,121, 684 net tons. Of this amount 83,151,024 tons were iron ore. Practically all ore passed through the American locks. Less than three million net tons representing all commodities used the Canadian lock. The Welland Canal also set a new high. Coal was the leading commodity through this waterway, 4,944,439 tons making a substantial part of the 11,956,673 net ton total for the canal.

Since the Great Lakes are not a year round waterway, the open season is one of great activity. A tremendous tonnage must be crowded into an eight month season. Speed is imperative, giant freighters a necessity. Ports must have harbors large enough and deep enough to accommodate vessels and powerful equipment to load and unload cargoes without delay.

The 1941 season on the Great Lakes was a record breaker. During the season 80,116,360 gross tons of iron ore moved down the Lakes, surpassing by some fifteen million the previous high of 65,204,600 tons moved in 1929. Three ports Marquette, Superior and Two Harbors, set new all-time highs in ore shipments. During the season 49,709,416 net tons of bituminous coal entered into lake traffic. This tonnage exceeded that of any other year. By late November Lake Erie ports passed all previous records for dumping bituminous coal and the season had not yet ended. During the season, approximately 20,000,000 tons of limestone moved in lake boats, surpassing the previous all-time high established in 1929.

Part of the increased tonnage of 1941 can be accounted for by deep loading which was inaugurated on June 15th. This made it possible for freighters to carry greater cargoes. The heavier cargoes necessitated adjustments to harbor depths in lower lake ports. On several occasions freighters discharged part of their ore cargoes at Cleveland before proceeding to the more shallow harbor at Buffalo for final unloading.

The 1941 season found all of the 292 vessels in the American ore fleet in operation. They were assisted by Canadian vessels, which, for the first time, were permitted to carry ore from one American port to another. The Canadian vessels carried seventy-two cargoes of approximately 695,000 tons. During the season the *Harry Coulby* of the American fleet established new cargo records without resorting to deep loading. On August 19th this vessel cleared Duluth-Superior with 16,335 gross tons of ore. This was its sixth cargo record of the season, surpassing its fifth record by ninety tons. On October 5th the *Coulby* delivered 15,026 gross tons of ore to Ashtabula. This was the largest cargo of the year for Lake Erie and the only one brought in by the *Coulby*.

The 1941 cost of transporting ore on the Great Lakes was seventy-seven cents per ton. Compared with similar hauls elsewhere this rate is significant. Ocean freighters carrying ore from Newfoundland to Boston received $3.25 per ton. The ocean

haul was 885 miles, about equal to that between Duluth and Ashtabula. The Great Lakes provide cheap transportation. They provide a direct route, an easy highway for the movement of heavy and bulky raw materials.

During 1941 storage space for grain was at a premium at both ends of the Great Lakes waterway. The United States had no export market and war conditions slowed the movement of Canadian grain. Consequently, emergency elevators were built at Fort William-Port Arthur and at Buffalo. In November 118,478,180 bushels of grain were in storage at Fort William-Port Arthur, 45,000,000 bushels at Duluth-Superior and 27,018,901 bushels at Buffalo.

While grain did not move as freely as formerly, there were other commodities to engage shipping. Lake vessels moved ore and coal in unprecedented amounts. If grain was carried, speedy unloading had to be guaranteed, otherwise, too much valuable time was lost. While the lake movement of wheat was light, the October movement of 25,942,367 bushels was well ahead of the 14,142,612 bushels carried in October 1940. November witnessed heavy shipments of grain near the end of the month. On November 27th, thirty vessels were in Fort William-Port Arthur for grain. Eleven cleared on November 27th with 3,196,000 bushels. On the 29th and 30th, forty ships cleared with 8,118,000 bushels. Clearing before midnight November 30th, they beat the increase in insurance rates.

Late in the season, vessels carried grain east and tied up for the winter with grain stored in their holds. On December 12th, over ten million bushels of wheat were reported in boats in Buffalo harbor. Erie, likewise, was holding large quantities in ship storage space. In volume and price of charters, the December grain business was the best in years. One boat chartered for loading at Duluth and holding at Buffalo received ten cents per bushel; another loading at Fort William and holding at Erie received eight and one-half cents per bushel.

Wheat was only one of the commodities held in ship storage space. South American flax wintered in freighters in Cleveland harbor and at South Chicago. Barley wintered at Milwaukee. The heavy concentration of flax at Cleveland was directly related to the paint industry of that city, while the brewing industry at Milwaukee accounted for the barley at that port. Cement also found freighter storage space at Cleveland.

During the season several automobile carriers were converted

into grain carriers. These vessels took autos to the head of the lakes and returned with grain. Some vessels engaged in carrying merchandise also returned with wheat from Lake Superior ports. Several of these at the close of the season took storage grain to Buffalo. The largest mixed grain cargo of the season was carried by the Canadian vessel, SS *Lemoyne*. The cargo was delivered to Hamilton, Ontario, on August 17th. It consisted of 561,000 bushels of wheat, barley and flax. While this cargo was the largest for 1941, it was not as large as a similar cargo carried by the *Lemoyne* in 1928.

The 1941 season brought new commodities to some of the Great Lakes ports. Chicago became active in the trans-shipment of sulphur and Buffalo in the trans-shipment of bauxite. For years sulphur had moved up the Atlantic coast from Louisiana and transferred to barges, had crossed New York state by Barge Canal to the port of Buffalo. Because of curtailed Atlantic shipping during 1941, this commodity used the Mississippi-Illinois waterway and was loaded into lake carriers at Chicago. The bauxite shipments originated in South America. They were transferred to barges on the eastern coast and reached Buffalo by way of the Barge Canal. At Buffalo they were transferred to Canadian boats and taken to the aluminum plant at Port Alfred in Quebec. On one day in late October, Buffalo reported two dozen canal barges awaiting trans-shipment. In 1940 sulphur provided the greatest tonnage on the Barge Canal. In 1941 bauxite led.

During the 1941 season, seventy-seven vessels engaged in the transportation of petroleum on the Great Lakes. Thirty-three were American tankers, thirty-four were Canadian. This fleet was augmented by barges from New York harbor and the New York Barge Canal. Tankers and barges carried 9,387,060 net tons or 68,948,523 barrels of petroleum during the season. Indiana Harbor and Toledo were the leading points of origin for shipments on the lakes. Cleveland was an important petroleum receiving port.

Tankers operated between Toledo and Cleveland long after other lake freighters tied up for the winter. Even after Christmas, petroleum was moving by water. The tanker *Paratex* of the Gulf Refining Company delivered a cargo in early January. When it left Cleveland on January 5th, 1942, ice was a serious problem. Coal was another late season commodity on Lake Erie. Shipments from Toledo to Detroit continued to the end of

the year. Ice finally necessitated a shift from water to rail transportation.

The 1941 tonnage on the Great Lakes exceeded that of previous years. All indications are that this record will be surpassed in 1942. The ever increasing tempo of war activities demands the basic heavy raw materials in unprecedented amounts. The estimated needs of 1942 far exceed those of 1941. With a favorable season, increased tonnage capacity and an all-out war effort, it is safe to predict the moving of heavy raw materials in 1942 will be an amazing accomplishment.

A CALENDAR OF THE BIRTHDAYS OF SCIENTISTS FOR APRIL AND MAY[1]

JAMES D. TELLER
College of Education, Ohio State University

Day	*Year*	*Name*	*Birthplace*	*Specialty*
APRIL				
1	1755	Anthelme Brillat Savarin	Belley, France	Gastronomist
1	1878	Petr Petrovich Lazarev	Moscow, Russia	Physicist
2	1877	Carl Lucas Alsberg	New York, New York	Bio-chemist
3	1693	George Edwards	Stratford, England	Naturalist
4	1688	Joseph Nicolas Delisle	Paris, France	Astronomer
4	1646	Antoine Galland	Rollot, France	Archaeologist
4	1809	Benjamin Pierce	Salem, Massachusetts	Astronomer
4	1823	Sir William Siemens	Lenthe, Hanover	Inventor
5	1801	Felix Dujardin	Tours, France	Biologist
5	1827	*Joseph Lister[2]	Upton, Essex, England	Physician
5	1819	Theodore Ruggles Timby	Dover, New York	Inventor
6	1869	Filippo de Filippi	Turin, Italy	Scientist
6	1810	Philip Henry Gosse	Worcester, England	Naturalist
6	1732	José Celestino Mutis	Cadiz, Spain	Naturalist
6	1766	*William Hyde Wollaston	East Dereham, Norfolk, England	Chemist
7	1859	*Jacques Loeb	Germany	Biologist
7	1809	James Glaisher	London, England	Meteorologist
8	1818	August Wilhelm von Hofmann	Giessen, Germany	Chemist
8	1732	David Rittenhouse	Germantown, Pennsylvania	Astronomer
9	1865	Charles Proteus Steinmetz	Breslau, Germany	Electrical Engineer
10	1766	Sir John Leslie	Largo, Fifeshire, Scotland	Physicist
11	1804	Otto Linné Erdmann	Dresden, Germany	Chemist
12	1849	Albert von St. Gallen Heim	Zurich, Switzerland	Geologist
12	1748	Antoine Laurent de Jussien	Lyons, France	Botanist
14	1857	Sir Victor Horsley	Kensington, London, England	Physiologist
14	1629	*Christiaan Huygens	The Hague, Holland	Physicist
14	1827	Augustus Henry Lane-Fox Pitt-Rivers	England	Archaeologist
14	1809	Friedrich Adolph Roemer	Hildesheim, Prussia	Geologist
15	1794	Pierre Flourens	Béziers, France	Physiologist
15	1772	*Étienne Geoffrey Saint-Hilaire	Étampes, Seine-et-Oise, France	Naturalist

Day	Year	Name	Birthplace	Specialty
APRIL				
15	1874	Johannes Stark	Schichenhof, Bavaria, Germany	Physicist
15	1793	Friedrich Georg Wilhelm Struve	Altona, Germany	Astronomer
16	1777	Henry Kater	Bristol, England	Physicist
16	1867	*Wilbur Wright	Milville, Indiana	Inventor
16	1850	Sidney Gilchrist Thomas	London, England	Inventor
17	1881	Robert Thompson Leiper	Kilmarnock, Scotland	Biologist
17	1794	Carl Friedrich von Martius	Erlangen, Germany	Botanist
19	1865	Samuel Avery	Lamoille, Illinois	Chemist
19	1795	Christian Gottfried Ehrenberg	Saxony, Germany	Naturalist
20	1860	Charles Gordon Curtis	Boston, Massachusetts	Inventor
20	1809	James David Forbes	Edinburgh, Scotland	Physicist
20	1798	Sir William Edmond Logan	Montreal, Canada	Geologist
21	1851	Charles Barrois	Lille, France	Geologist
21	1774	Jean Baptiste Biot	Paris, France	Physicist
21	1849	Oscar Hertwig	Friedberg, Germany	Embryologist
23	1877	Hans Fitting	Halle, Germany	Botanist
23	1805	Augustus Addison Gould	New Ipswich, New Hampshire	Conchologist
23	1858	Max Planck	Kiel, Germany	Physicist
24	1832	Jean Louis René Antoine Edouard Claparède	Geneva, Switzerland	Naturalist
24	1787	Mathieu Joseph Bonaventure Orfila	Mahon, Spain	Toxicologist
25	1854	Hertha Ayrton	Portsea, England	Scientist
25	1769	Sir Marc Isambard Brunel	Hacqueville, Normandy	Inventor
25	1875	*Marchese Guglielmo Marconi	Bologna, Italy	Inventor
26	1785	*John James Audubon	Santo Domingo	Naturalist
26	1774	Christian Leopold von Buch	Stolpe, Pomerania	Geologist
26	1789	Robert Were Fox	Falmouth, England	Geologist
26	1812	*Alfred Krupp	Essen, Germany	Metallurgist
26	1879	Owen Williams Richardson	Dewsbury, Yorkshire, England	Physicist
27	1791	*Samuel Finley Breese Morse	Charlestown, Massachusetts	Inventor
28	1753	Franz Carl Achard	Berlin, Germany	Chemist
28	1831	Peter Guthrie Tait	Dalkeith, Scotland	Physicist
30	1723	Mathurin Jacques Brisson	Fontenay, le Comte, France	Zoologist
30	1777	*Karl Friedrich Gauss	Brunswick, Germany	Physicist
MAY				
1	1824	Sir Johann Franz Julian von Haast	Bonn, Germany	Geologist
1	1852	Ramon Y Cajal Santiago	Petilla de Aragon, Spain	Histologist
1	1824	Alexander William Williamson	London, England	Chemist
2	1802	Heinrich Gustav Magnus	Berlin, Germany	Chemist
2	1868	Robert Williams Wood	Concord, Massachusetts	Physicist
4	1825	*Thomas Henry Huxley	Ealing, England	Biologist
4	1816	Thomas Oldham	Dublin, Ireland	Geologist
4	1777	Louis Jacques Thénard	Louptiére, France	Chemist
5	1809	Frederick Augustus Porter Barnard	Sheffield, Massachusetts	Scientist
5	1811	John William Draper	Liverpool, England	Scientist
6	1843	Grove Karl Gilbert	Rochester, New York	Geologist
7	1807	Sir Isaac Holden	Hurlet, England	Inventor
8	1698	Henry Baker	London, England	Naturalist
8	1855	Bohuslav Brauner	Prague, Czechoslovakia	Chemist
8	1842	Emil Christian Hanson	Ribe, Jutland	Botanist
10	1788	*Augustin Jean Fresnel	Broglie, Normandy, France	Physicist
10	1830	Francois Marie Raoult	Fournes, France	Chemist
11	1752	Johann Friedrich Blumenbach	Gotha, Germany	Physiologist
11	1722	Peter Camper	Leiden, Holland	Naturalist
11	1828	Eleanor A. Ormerod	Gloucestershire, England	Entomologist
12	1803	*Justus von Liebig[2]	Darmstadt, Germany	Chemist
13	1837	Daniel Garrison Brinton	Thornbury, Pennsylvania	Archaeologist

Day	Year	Name	Birthplace	Specialty
MAY				
13	1854	Yves Delage	Avignon, France	Zoologist
13	1795	Paul Girard Deshayes	Nancy, France	Geologist
13	1850	Oliver Heaviside	London, England	Physicist
14	1686	*Gabriel Daniel Fahrenheit	Danzig, Germany	Physicist
15	1859	*Pierre Curie	Paris, France	Physicist
15	1847	*Sir Edwin Ray Lankester	London, England	Biologist
15	1821	Henri de Lacaze-Duthiers	Montpezat, France	Zoologist
15	1845	Ilya Mechnikov	Ivanovka, Kharkov, Russia	Biologist
15	1835	Henrik Mahn	Bergen, Norway	Meteorologist
16	1800	Ebenezer Emmanos	Middlefield, Massachusetts	Geologist
16	1763	Louis Nicolas Vauquelin	Hébertot, Normandy, France	Chemist
17	1817	Thomas Davidson	Edinburgh, Scotland	Palaeontologist
17	1741	Barthélemy Faujas de Saint-Fond	Montélimart, France	Geologist
17	1749	*Edward Jenner	Berkeley, Gloucestershire, England	Physician
17	1836	*Sir Joseph Norman Lockyer	Rugby, England	Astronomer
18	1872	Bertrand Arthur William Russell[2]	Trelleck, Monmouth, England	Philosopher of Science
19	1857	John Jacob Abel	Cleveland, Ohio	Pharmacologist
20	1807	*Jean Louis Rodolphe Agassiz	Lake Morat, Switzerland	Naturalist
20	1860	Eduard Buchner	Munich, Germany	Chemist
20	1772	Sir William Congreve	England	Inventor
20	1848	*George John Romanes	Kingston, Canada	Biologist
21	1845	Charles Edwin Bessey	Milton, Ohio	Botanist
23	1871	Nikodem Caro	Lódz, Germany	Chemist
23	1862	David George Hogarth	Barton-on-Humber, Lines, England	Archaeologist
23	1718	William Hunter	East Kilbride, Lanark, England	Physiologist
23	1848	Otto Lilienthal	Auklam, Germany	Inventor
23	1707	*Carl von Linné	Råshult, Småland, Sweden	Botanist
23	1817	Gustave Adolphe Thuret	Paris, France	Botanist
24	1861	Sir Wyndham Rowland Dunstan	Chester, England	Scientist
24	1544	*William Gilbert	Colchester, England	Man of Science
24	1793	Edward Hitchcock	Deerfield, Massachusetts	Geologist
24	1824	Wilhelm Friedrich Benedict Hofmeister	Leipzig, Germany	Botanist
25	1860	*James McKeen Cattell	Easton, Pennsylvania	Editor
25	1865	Pieter Zeeman	Zaunemaire, Zeeland	Physicist
26	1826	Richard Christopher Carrington	London, England	Astronomer
26	1837	Henry Hicks	St. David's, Pembrokeshire, Wales	Geologist
26	1799	Felipe Poey Y Aloy	Havana, Cuba	Naturalist
28	1747	Francois Pierre Nicholas Gillet de Maumont	Paris, France	Mineralogist
28	1861	High Robert Mill	Thurso, Scotland	Meteorologist
31	1872	*Charles Greeley Abbot	Wilton, New Hampshire	Astrophysicist

[1] All data are taken from *The Encyclopaedia Britannica*, 14th edition, unless otherwise indicated. For the uses and limitations of such a calendar, the reader is referred to the article which accompanies the calendar for October in SCHOOL SCIENCE AND MATHEMATICS, Volume XLI, pp. 611–619, October, 1941. Calendars for the following months will be found in *ibid.*, Volume XLI, p. 768, November, 1941; *ibid.*, Volume XLI, pp. 884–885, December, 1941; *ibid.*, Volume XLII, pp. 87–88, January, 1942; *ibid.*, Volume XLII, pp. 187–188, February, 1942; *ibid.*, Volume XLII, pp. 207–208, March, 1942.

[2] Data for this entry are taken from *The Encyclopedia Americana*, 1939 edition.

* The starred names have been used by the writer in various bulletin board projects during the past twelve years.

PREPARATION OF SCIENCE TEACHERS TO CONTRIBUTE TO GENERAL EDUCATION[1]

SAMUEL RALPH POWERS

Professor of Natural Sciences, Teachers College, Columbia University, and Chairman of the Subcommittee on Teacher Education of the National Committee on Science Teaching

For some months the Subcommittee on Teacher Education of the National Committee on Science Teaching has been working at the problem of discovering and formulating the changes needed in the education of science teachers. The report of the Subcommittee is an exploration of the present American scene and a definition, made in the light of this exploration, of work of teachers with special competence in science, and of the responsibilities placed upon institutions which train such teachers.

Practices in education are influenced by the conditions of the times in which they are current and seem to represent a fusion resulting from conflict between apparent demands of an immediate and ongoing social milieu and traditional procedures based upon supposed needs of the past. It is for this reason that organized attention and group reports are frequently needed. The present report is best seen in relation to previous reports which have influenced science teaching in general including the education of science teachers.

Early reports, that of the Committee of Ten in 1893, that of the Committtee on College Entrance Requirements in 1896, and that of 1906 which defined the Carnegie units, all tended to fix science firmly as a college preparatory subject and to set its objectives within those bounds. However, the early years of the century saw the high school population change to include more and more students who did not plan to go to college. In 1918 a committee of the National Education Association published the *Cardinal Principles of Secondary Education* followed in 1920 by the well-known *Bulletin 26* on *Reorganization of Science*. Both these reports placed emphasis on education for direct functional values. They also stressed the importance of a continuous and progressive program from the kindergarten to the university.

This series of reports, stressing on the one hand subjects and college preparation, on the other the development of individuals,

[1] The report of the Subcommittee on Teacher Education of the National Committee on Science Teaching was submitted to the general committee in February 1942, in a manuscript of approximately 100 pages.

inevitably caused confusion in school administration and in the minds of teachers. The *Thirty-first Yearbook* of the National Society for the Study of Education emphasized the impact of science on human affairs and defined the scientific principles and generalizations to be stressed in education because of their bearing on human interests and welfare. Present trends as interpreted in *Science in General Education* and other publications of the Progressive Education Association, in the *Reports of Educational Policies Commission* of the National Education Association, and in other treatises make the activities of people more than ever the center of attention; the problems, interest, and ideals recognized in these activities are seen as defining the goals of education. The present Subcommittee has taken as its specific task, first, the definition of the functions of teachers with special competence in science in present day affairs, and second, recommendations of materials and procedures to help prospective teachers with special interest in science gain the ability to fulfill those functions.

Aspects of Our Culture

The youth of today is facing a world of contradictions—of want in the midst of plenty, of fear in an age of potential security, of greed and selfish interest in a society supposedly influenced by the ethics of Christianity, of economic insecurity, class stratification, and restraint of human rights in a political democracy, and of wars and recurring crises in the "scientific" twentieth century. It is in this world of contradiction, in this welter of confusion that the teacher is challenged; it is here that the teacher of science finds his reponsibility; for it is amid these confusions that he must help young people solve their problems.

Present Trends in American Education

The Subcommittee has been guided in the preparation of its recommendations for education of science teachers by consideration of the general trends in American education. These trends show:

1. A renewed emphasis upon the desirability of elementary and secondary education for all young people. There is a resultant drive to provide education for all types and levels of intellectual ability.
2. A further de-emphasis of preprofessional preparation, and an increasing tendency to identify it with common educative experience. The tradition of college preparation is still strong, but it is yielding to

persistent demands for meeting the needs of the more numerous noncollege students.

3. An extended program of general education with delayed specialization. The general education program is characterized by the substitution of functional areas for traditional academic subjects, more flexibility, less formality, and greater attention to social needs.
4. A remarkable growth of vocational education, with a broad interpretation of its meaning, which includes preparation for total adjustment of the individual to occupational life.
5. A recognition of educational values accruing from work and firsthand activities, and exaltation of such values as equal to or above those of traditional "book learning."
6. An increased emphasis upon social and citizenship education directed to participation of the individual in home, family, and community life. Characterizing features are attention to (a) the principles of democracy and means for preserving and advancing them; (b) the development of personality and moral character; (c) the consideration of topics and questions that are controversial; and most recently (d) a consideration of the defense needs of the United States.
7. A recognition of educational values in recreational and leisure-time pursuits.
8. A recognition of economic demands including utilization of resources, conservation, and problems of spending. With this goes a reemphasis upon aspects of physical and mental health, and extension of health services.
9. A re-emphasis of certain fundamental skills commonly considered to be the domain of the elementary school; notable among these is the centering of attention upon reading for information and for intellectual development and on computation such as is necessary to budgeting and to consumer buying.
10. Organization of the elementary-school curriculum into integrated units which gives an opportunity for science to develop in relation to social studies. Subjects no longer compartmentalized in the modern school represented by grades one to six. This is increasingly true of the secondary school as well.

Status of and Trends in Science Education

There can be no doubt that science teachers in many schools have failed to keep adequately in touch with trends in education and with the social, economic, and political developments of the dynamic society of which they as individuals and as teachers are a part. This is obvious to anyone who will take the trouble to observe it. Science teachers and science departments have been committed to the development and perpetuation of academic disciplines of college preparatory subjects and have thus been separated from the actual processes of community life. Driven by the demands of subject-matter accomplishment and academically imposed standards which all too frequently ignore the relationship of knowledge to intelligent behavior, the teacher with scientific competence has been allocated to, and circumscribed by, classrooms, demonstration halls, laboratories, and

curriculums, and too seldom catches glimpses of the forces and processes determining the community's destiny. Specifically, it may be stated that, for the most part:

1. The teacher of science does not become in common practice an active force in the community of which he is a part. Living in a community should involve more than physical presence; it should mean helping to shape the community's hopes and aspirations and sharing its losses and defeats.
2. The teacher of science has not been taught the processes that are vital to community life and the factors that make for social changes.
3. The teacher of science does not recognize sufficiently the interdependence of social welfare and scientific procedures and technology. When the teacher fails in the perception of this important relationship, his students are likely to be left groping for ways and means to apply the information acquired in science courses to practical problems.
4. The teacher of science has not kept himself and his co-workers adequately informed about the recent scientific accomplishments immediately affecting personal and social welfare. As a result, "the educational system has not caught up with the flood of new scientific knowledge about the national and social world which has been made part of life in recent decades, and fails to give boys and girls a scientific point of view and understanding of the world." (The Regents' Inquiry.)
5. The teacher of science does not and too often cannot because of inadequacies in his education deal with community goals for human betterment, or advise in their determination. It is recognized that many communities lack well-defined and commonly accepted programs. The obvious goals of the better organized communities result largely from exploitation of abundant natural resources, such as coal, rich farm land, water power, and other materials and energy. Only recently has there been effort to define and condition social and economic goals; only rarely has formal education shared in this effort.

The trend for education to face realistically the problems of today is recognized by thoughtful persons both within and without the school. The public, aware of the stress of the times, is increasingly responsive to the proposal that schools give attention to the important concerns with which youth and society must deal. Educators are recognizing the urgency of present problems and of the school's reponsibility to meet the needs of "all the children of all the people" who now comprise our school population. Teachers with special competence in science, recognizing the existence of many problems in which science and technology have been determining factors, feel a responsibility to help young people study those situations which are particularly in the province of scientific analysis and treatment.

This last statement is borne out by the results of a national survey conducted by the Subcommittee. Science teachers all over the country were asked to express their agreement or lack

of agreement with a series of statements all related to the general question:

Should science teachers deal in their teaching only with the empirically determined body of scientific facts of their subject matter, or should they engage in socially significant controversial areas which go beyond the obtained facts into the areas of opinion and value judgment?

A large majority of the teachers expressed themselves as of the opinion that an important function of science education is to deal with present unsolved problems and offer the best scientific evidence on them. Conversely, very few indicated their belief that science teachers should deal only with areas in which conclusive factual material is available.

The same study showed, however, that large numbers of teachers avoid in their teaching the very topics which they believe to be important. One reason given is that their training has not fitted them for the task. They believe that the curriculums of liberal arts colleges and teachers' colleges provide the kind of training in science which was originally designed for research workers, engineers, and physicians; that the organization and content are the organization and content of subject matter leading to research excellence; and that the needs of science teachers have been neglected. Here is a challenge for teacher education.

It seems evident from studies such as that quoted that changes in teacher education should be in the direction of placing greater emphasis on the teacher as a participant and leader in democratic living. Specifically it is suggested that prospective science teachers should be helped to:

1. Gain an understanding of American cultural groups.
2. Gain an understanding of the variety of institutional forms of past and present societies.
3. Understand the potential relations of scientific research to democracy.
4. Understand himself and his students, their parents and others in the community.
5. Develop leisure activities and aesthetic satisfactions.
6. Develop satisfying conceptions of life.

Education for Competency

Education for the competency that is required of science teachers calls for proficiency in aspects of science that are immediately functional. If the function of the teacher with special competence in science is to assist in analyzing the needs of individuals and society, and to help his students develop the attributes essential to meeting them successfully, it is clear that his education must

develop in him an expertness precisely in regard to this task. Obviously the development of special competence in science means he must be given adequate preparation in the subject matter and methods of science. In addition he should be well informed as to the issues of contemporary life and be able to apply scientific subject matter and methods to their clarification. A broad understanding of people and their ways of living and of the major problems of our culture not only will enrich the personal life of the teacher but will make him more able to deal with the concerns of youth and society.

This must not be construed to mean that the job of the teacher with competence in science is identical with, for example, that of the teacher who is prepared to give instruction in the social sciences or the humanities. It does mean that each teacher, with whatever expertness he possesses, should contribute to the resolution of practical problems which confront individuals and groups. (The term *problem* is here used in its broadest meaning.) In this period of civilization, marked indelibly by the achievements and the views of science, there is every reason for experts from that field to engage cooperatively with social scientists, artists, historians, and others in interpreting, clarifying, and helping to make decisions on matters immediately pertinent to our society. That the science teacher will not handle every type of human and social problem, and that he will not lend the same emphasis as other teachers to those he does deal with, goes without need of elaboration. But it is clear that he can make an important contribution to the education of youth by virtue of his special training.

Teachers' colleges and schools of education should assume leadership in experimenting, planning, and developing curricular materials and procedures which will aid both the teachers now in service and those in training to accept fully the responsibility to which they subscribe. Already there are several centers in which reorganization and experimental procedures are being tried. It would be presumptuous and narrow for the Committee to recommend any particular form of organization or curricular pattern at this time. Exploration, study, and experimentation have not been sufficient to warrant definitive statements of exact direction. Indeed, it is most reasonable to assume that there is no "best" pattern or sequence of courses, but that there are many ways in which functional specialization can be accomplished.

Forward-looking teachers on all levels have been attempting curricular developments along lines specified by the demands of our society, and their experiences may be capitalized in the search for useful functional areas of specialization. Two other subcommittees of the National Science Committee, that on Philosophy and that on Needs in Relation to the Science Program, have developed lists of desirable educational goals. The Subcommittee on Teacher Education suggests the following as possible areas of study for prospective science teachers; it is believed that these offer opportunity for study directed specifically toward the educational goals contained in the other subcommittee reports. The list should be considered illustrative rather than definitive:

The human life span
Variation among living things, especially human beings, and genetic and environmental influences
Maintenance of personal health
Maintenance of public health
Control of organisms
Biological production including good land use
Interrelations of living things
Production, distribution, and consumption of materials
Impact of technology and invention on Western civilization
Energy forms; the transformation and utilization of energy in modern civilization
The nature of the earth and the universe
Chemical changes, solutions, atomic structure, and the nature of matter

It is obvious that none of these represents new *kinds* of subject matter or even new organizations. All have been tried with promising degrees of success in various institutions interested in the education of teachers. For example, large numbers of such institutions now offer courses in child development which present material chosen from physiology, psychology, nutrition, and to some extent anthropology. Many institutions are finding that, in order to understand the development of children, students must have broader perspective than that gained from study of children alone; they must pay attention to the characteristics and problems of adult life and old age, to heredity and prenatal influences. When we look at present day society, the changes in our population structure, the increasing number of elderly people and the influence they exert in our personal lives, in economics and politics are recognized as of great importance. For these various reasons then the Subcommittee feels that it is desirable to expand the work being devoted to one

phase of human existence, that of childhood, and consider the whole human life span. Similarly, courses are already being given in which the center of interest is health. In some cases excellent courses of this kind reach only a few students. Many institutions, also, have been experimenting with organizations of courses within the fields of the physical sciences which bear more directly than traditional organizations on the problems of technology which our age is facing, on the availability of materials and energy, methods of production and use to conserve our resources and at the same time make possible a higher standard of living. The recommendation is here made that these courses be reviewed again and again to make sure that they include the most important aspects of the new knowledge continually being acquired in the many fields involved and that the relations of our knowledge to present day problems are made clear. It is further recommended that some study in these fields be made available to all prospective teachers of science.

Competency for science teachers must include a realistic understanding of science and of scientific method. This means: (1) thorough grounding in the scientific facts and principles in fields of special interest and enough acquantance with those in other fields to make further study and evaluation of authorities possible; (2) comprehension of, and ability to apply, the methods of science used in different fields; (3) comprehension of the relationships between the different sciences and their applications in life-problems; (4) comprehension of how the sciences have affected, and can affect, personal and social life.

The resources on which to draw for the development of this competence are the teaching staff of colleges and the materials and equipment they have at their command. Objectives of teacher education endorsed by the Subcommittee already have widespread acceptance, and curriculum planning to accomplish them is in progress. The aim that is foremost in this planning is the enabling of college teachers to use their competence, the equipment of the colleges, including libraries and laboratories, and such other resources as they may command, to help prospective teachers prepare for their work. It is clear that some of the material ordinarily offered in traditional courses would be irrelevant, and should be omitted. It is equally clear that in the construction of new sequences materials not ordinarily found in the usual courses but essential to the work of the teacher should be included as need for them is discovered.

Education of Science Teachers Includes Professional Orientation

The education of the teacher is not confined to achievement of subject-matter competence as described above. This should be integrally related to the acquisition of professional orientation and technics.

Because of this the Subcommittee suggests that the greatest responsibility that falls on the professional school or department of education is to counsel and work with the staff of the science department in securing reorganization of its work into areas of functional importance for teachers. The professors in the various sciences should take the major responsibility for education in science. But if the education in science is to be planned and carried out as the Subcommittee has proposed, it will require the close cooperation of professors in both science and education.

In addition to this responsibility, the professional school carries that for the development of attitudes, technics, and insights necessary to the teacher's work. What shall be the specific nature of this professional education of the teacher of science? What viewpoints, insights, skills, and information of a professional nature will he need? How can he be aided in the development of a vision of the possibilities that his teaching may offer to the youth of America? How can he be made interested in constant analysis of the adequacy of his teaching for the changing needs and concerns of the society in which he works? By what methods can his constant attention to curricular development and personal growth in the coming years of service be assured? How can he be helped to see the interrelatedness of the contributions made by creative workers—artists, historians, economists, and scientists—when they are viewed as contributors to human welfare? How can he gain an understanding of the children with whom he will work, so that he will help them solve their problems and develop their interests rather than act as an outsider toward whom they must show respectful but diffident attention? How can he be helped to consider the community his laboratory; its problems his materials; science his methods; and the whole of society as defining the area in which he works and lives?

Professional education can best deal with these questions if four important aspects of professional understanding are emphasized in the preparation of science teachers: (1) an understand-

ing of the community in which the teacher works; (2) an understanding of the children with whom the teacher works; (3) an understanding of good teaching practices; and (4) an understanding of the relation of the work of science teaching to other aspects of education and an appreciation of the responsibility of the science teacher to young people and society.

Inservice Education

In the preparation of the report the Subcommittee has thought of preservice education as only the beginning of a program of professional education to continue through the period of active service. No part of the teacher's education may be thought of as completed. The recommendations are for courses to provide the kinds of educational experiences that will open areas of interest and importance and do it in such a way as to make these areas enriching to the personal life of the teacher and at the same time vocational.

JUNIOR COLLEGE ENROLLMENT

Neither the draft nor increased employment opportunity for young people has kept any significant number of junior college students away from their books, according to enrollment figures collected from all junior colleges in the country by Walter C. Eells, executive secretary of the American Association of Junior Colleges.

In one year the nation's two-year colleges have added 31,000 young people to their enrollments, increasing the total enrollment from 236,162, as reported last year, to 267,406 reported this year, a growth of 13.2 per cent.

This increase despite changed national conditions is not to be interpreted, Dr. Eells points out, as a desire of young people to avoid active military service, but on the contrary to their desire to be of the greatest possible service to the country. They are acting on advice by President Roosevelt, selective service officials, and college heads, to remain in college until called in order that they may help supply the trained personnel the country so badly needs.

Proof of their patriotic purpose is seen in the decided change in the courses they seek. The special training courses being offered by the junior colleges for direct employment in defense industries are in the front-line of popularity with young men, while the young women seem especially interested in the two-year junior college courses for dental and medical assistants and nursing which prepare for the important health fields where there is such a serious shortage of qualified people today.

It is also significant that whereas in past years many students attended junior college with plans to transfer to the third year of a four-year college or university, today the majority are taking two-year "terminal" courses leading to a junior college degree, usually the Associate in Arts, before they are 20 years of age.

SOME ADDITIONAL NOTES ON A PROBLEM OF STEINHAUS

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Mr. H. I. Dohner's article "On a Problem of Steinhaus" which appeared in the November 1941 issue of this journal served to recall to the present writer some notes of his own on this subject. These are presented below.

The area relationships, obtained by Mr. Dohner directly from the ratios set up on the sides of the primary triangle, are derived in a more prosaic fashion by first considering the linear relationships on the rest of the figure. Since these linear relationships do, however, lead to some special items on their own account, there is some recompense. Furthermore, due to a difference in the meaning of n, all results come out in somewhat modified form. An additional inference about areas, suggested by a different grouping of the subdivisions of the primary triangle, completes the sketch.

Following Mr. Dohner, we use i, j, k to represent a cyclic permutation of 1, 2, 3. This permits the following statement of the main result:

Theorem. On side A_iA_k of triangle $A_1A_2A_3$ point B_j is taken so that $A_iB_j = n \cdot B_jA_k (n>0)$. and lines A_iB_i and A_jB_j are drawn to intersect at C_k; then $A_iB_i : A_iC_j : C_jC_k : C_kB_i = n^2+n+1 : n+1 : n^2-1 : 1$, and $\triangle A_1A_2A_3 : \triangle A_iC_jB_k : \triangle A_iA_jC_k : \triangle C_1C_2C_3 = n^2+n+1 : (n+1)^{-1} : n : (n-1)^2$.

Proof: (See figure 1.) Through B_i draw a line parallel to A_kB_k, meeting A_iA_j at D_i. Then $\triangle A_iA_jB_j \sim \triangle A_iB_kD_k$, and $\triangle A_iC_jB_k \sim \triangle A_iB_iD_i$.

Hence

$$\frac{D_iA_i}{B_kA_i} = \frac{D_iB_k + B_kA_i}{B_kA_i} = \frac{D_iB_k}{B_kA_i} + 1 = \frac{D_iB_k}{A_jB_k} \cdot \frac{A_jB_k}{B_kA_i} + 1$$

$$= \frac{A_kB_i}{A_kA_j} \cdot \frac{A_jB_k}{B_kA_i} + 1 = \frac{n}{n+1} \cdot \frac{n}{1} + 1 = \frac{n^2+n+1}{n+1}.$$

Consequently

$$\frac{A_iB_i}{A_iC_j} = \frac{D_iA_i}{B_kA_i} = \frac{n^2+n+1}{n+1}.$$

Also,

$$\frac{A_iB_i}{C_kB_i}=\frac{A_iB_i}{B_jD_j}\cdot\frac{B_jD_j}{C_kB_i}=\frac{A_iA_k}{B_jA_k}\cdot\frac{D_jA_j}{B_iA_j}=\frac{n+1}{1}\cdot\frac{n^2+n+1}{n+1}.$$

Hence,

$$\frac{A_iB_i}{C_kB_i}=\frac{n^2+n+1}{1}.$$

Finally, from $C_jC_k=A_iB_i-A_iC_j-C_kB_i$ we find

$$\frac{C_jC_k}{A_iB_i}=\frac{n^2-1}{n^2+n+1}.$$

The area ratios are now readily obtained. Since triangles with the same altitude are in the ratio of the bases,

$$\frac{\triangle A_1A_2A_3}{\triangle A_iC_jB_k}=\frac{\triangle A_1A_2A_3}{\triangle A_iA_kB_k}\cdot\frac{\triangle A_iA_kB_k}{\triangle A_iC_jB_k}=\frac{n+1}{1}\cdot\frac{n^2+n+1}{1}.$$

Since triangles are in the ratio of the products of sides which include equal angles,

$$\frac{\triangle A_iC_jB_k}{\triangle A_iA_jC_k}=\frac{B_kA_i\cdot A_iC_j}{A_jA_i\cdot A_iC_k}=\frac{1}{n+1}\cdot\frac{n+1}{n^2+n}=\frac{1}{n(n+1)},$$

and

$$\frac{\triangle A_iC_jB_k}{\triangle C_1C_2C_3}=\frac{A_iC_j\cdot C_jB_k}{C_jC_k\cdot C_iC_j}=\frac{n+1}{n^2-1}\cdot\frac{1}{n^2-1}=\frac{1}{(n+1)(n-1)^2}.$$

This completes the proof of the theorem.

The triangles $A_1A_2A_3, A_iC_jB_k, A_iA_jC_k, C_1C_2C_3$ will be referred to as primary, corner, side and central respectively. The ratio $n:1$ will be called the primary ratio.

We proceed to consider some corollaries.

1. (See figure 2.) Through A_i draw a line parallel to A_jB_j, meeting A_kB_k at E_k. The three triangles $A_iC_jE_k$ are similar to the central triangle and congruent to each other.

Proof: From the parallel lines involved it is apparent that the four triangles are mutually equiangular, and hence similar. Then

$$A_iC_j:C_jC_k=C_jE_k:C_iC_j.$$

By the theorem,

$$A_iC_j:C_jC_k=A_kC_i:C_iC_j.$$

Hence $A_kC_i=C_jE_k$, making congruent triangles.

2. (See figure 3.) Through B_i draw a line parallel to A_kB_k, meeting A_jB_j at F_j. The three triangles $B_iF_jC_k$ are similar to the central triangle and congruent to each other.

Proof: Parallel lines cause similarity. Proceeding as above, we find $F_iC_j=C_kB_i$, making congruent triangles.

3. (See figure 4.) Draw the triangle $B_1B_2B_3$, and let B_iB_k intersect A_jB_j at H_j. Then $B_iH_j:H_jB_k=1:n^2$.

Proof: From corollary 2, the parallel to A_jB_j through B_k meets A_iB_i at F_i, making $F_iC_j=C_kB_i$. Hence $F_iC_k=C_jB_i$.
By the theorem,

$$C_jC_k:C_kB_i=n^2-1:1.$$

By composition,

$$C_jB_i:C_kB_i=n^2:1.$$

Then

$$B_iH_j:H_jB_k=C_kB_i:F_iC_k=C_kB_i:C_jB_i=1:n^2.$$

4. The medians of a triangle are concurrent in a point which is two-thirds the distance from any vertex to the midpoint of the opposite side.

Proof: Since A_jB_j is a median, $A_iB_j=B_jA_k$, and $n=1$. Applying the theorem,

$$A_iB_i:A_iC_j:C_jC_k=3:2:0.$$

The zero indicates concurrence, and the 3:2 completes the corollary.

5. If $n=2$, then $A_iB_i:A_iC_j:C_jC_k:C_kB_i=7:3:3:1$, and $\triangle A_1A_2A_3:\triangle A_iC_jB_k:\triangle A_iA_jC_k:\triangle C_1C_2C_3=7:\frac{1}{3}:2:1$. (Figure 2 is drawn to illustrate this corollary.) This is the case to which Steinhaus[1] refers, noting the 7:1 area ratio. The figure possesses various properties. Each one mentioned below occurs only when $n=2$, as examination of the proper governing equation reveals.
a) C_j is the midpoint of A_iC_k; $n+1=n^2-1$.
Hence, also, $\triangle C_1C_2C_3$ is congruent to each $\triangle A_iC_jE_k$.
b) $C_jC_k=(n+1)C_kB_i$; $n^2-1=n+1$.
c) Side $\triangle=n$ (central $\triangle$); $n=n(n-1)$.[2]

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[1] Steinhaus, H., *Mathematical Snapshots*, G. E. Stechert & Co., New York, p. 7.

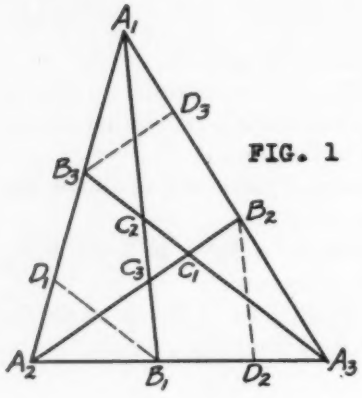

FIG. 1

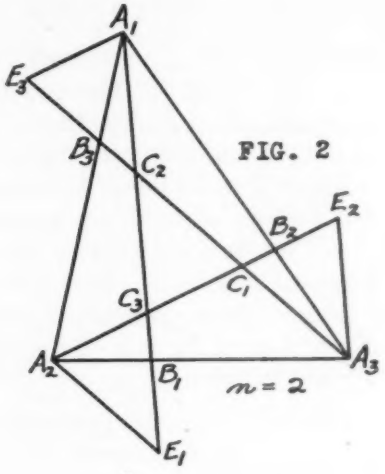

FIG. 2

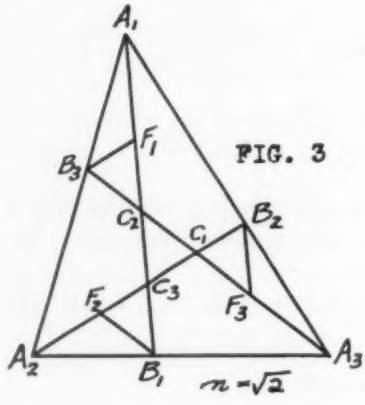

FIG. 3

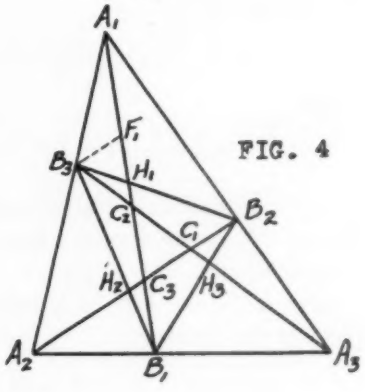

FIG. 4

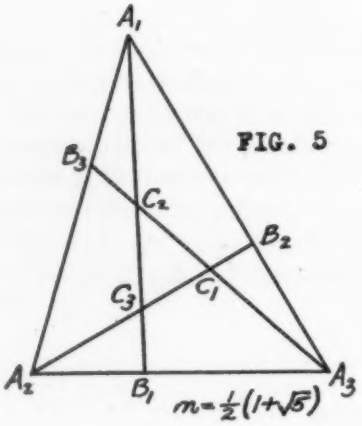

FIG. 5

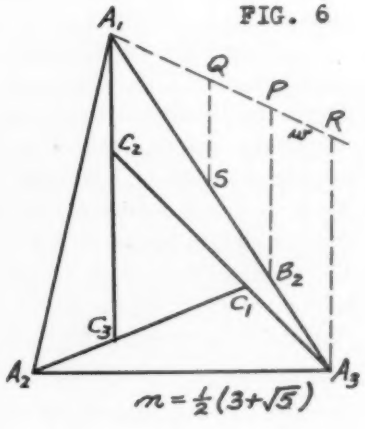

FIG. 6

d) Central $\Delta = (n+1)$ (corner Δ); $(n-1)^2 = (n+1)(n+1)^{-1}$.
e) Primary Δ:central $\Delta = A_iB_i : C_kB_i$; $n^2+n+1 : (n-1)^2 = n^2+n+1 : 1$.

6. If $n = \sqrt{2}$, then $\Delta C_1C_2C_3$ is congruent to each $\Delta B_iF_jC_k$. (Figure 3 is drawn to illustrate this case.)

Proof: By corollary 2, $\Delta C_1C_2C_3$ is similar to each $\Delta B_iF_jC_k$. If, then, $C_jC_k = C_kB_i$, the conclusion follows. By the theorem, $C_jC_k = C_kB_i$ if $n^2 - 1 = 1$. Now $n = \sqrt{2}$ satisfies this equation, and hence the corollary.

7. If the primary ratio is that which produces the golden section, then C_j is the midpoint of A_iB_i, C_k divides C_jB_i in the golden section, and the central triangle is equal to each corner triangle. (See figure 5.)

Proof: For the golden section, $n+1 : n = n : 1$, so that $n^2 = n+1$. By the theorem, $A_iC_j = C_jB_i = C_jC_k + C_kB_i$ if $n+1 = n^2$.

From $n^2 = n+1$ we have $n^2 - 1 = n$. By the theorem, $C_jC_k : C_kB_i = n^2 - 1 : 1$. Hence $C_jC_k : C_kB_i = n : 1$, where n produces the golden section.

From $n^2 = n+1$ we have $(n+1)(n-1) = n$ and $n(n-1) = 1$. Hence

$$(n+1)(n-1)^2 = 1, \quad \text{or} \quad (n-1)^2 = (n+1)^{-1}.$$

By the theorem, central Δ = corner Δ if $(n-1)^2 = (n+1)^{-1}$.

8. If the primary ratio exceeds by one the ratio which produces the golden section, then the central triangle is equal to each side triangle. (See figure 6.)

Proof: By hypothesis, $n = m+1$, where $m+1 : m = m : 1$. Then, since $m = n-1$, $n : n-1 = n-1 : 1$, or $(n-1)^2 = n$. By the theorem, central Δ = side Δ if $(n-1)^2 = n$.

To construct this figure, consisting of four equal triangles, proceed as follows: Draw through A_i a line w, different from A_iA_k. Divide any segment A_iP on w in the golden section, obtaining point Q. Take point R on w, making $QP = PR$. Draw RA_k, and determine B_j by constructing PB_j parallel to RA_k.

Proof: Draw QS parallel to RA_k, making $SB_j = B_jA_k$. Then $A_iB_j = n \cdot B_jA_k = n \cdot SB_j$, and $A_iS = (n-1)SB_j$. Since Q divides A_iP in the golden section, the parallel lines make

$$A_iB_j : A_iS = A_iS : SB_j.$$

Dividing each term of this proportion by SB_j we get

$$n : n-1 = n-1 : 1.$$

Hence

$$(n-1)^2=n, \text{ as required.}$$

We conclude with the mention of some other results easily demonstrated.

Let k denote the ratio primary $\triangle$:central $\triangle$. Then $k=7$ when $n=2$, as in corollary 5. This is the only case in which both n and k are integers. To make this clear note that, for $n>1$, k increases or decreases according as n decreases or increases. Now when $n=1$ there is no central triangle (corollary 4). Hence n is not an integer for any integral $k>7$. For $k=2, 3, \cdots, 6$ we may consult the equation

$$k=\frac{n^2+n+1}{(n-1)^2}.$$

This, when solved for n, has the discriminant $12k-3$. Substitution of the above integers for k indicates n irrational in each case. The uniqueness of $n=2$, $k=7$ follows.

If n takes any of the values $\frac{2}{1}, \frac{3}{2}, \frac{4}{3}, \cdots$, the corresponding k is integral. In fact, if $n=(a+1)/a$ or $a/(a+1)$, then $k=3a^2+3a+1$. Any other integral k requires an irrational n.

NEW PRESIDENT OF GINN AND COMPANY

At the February meeting of the directors of Ginn and Company, Mr. Frederick A. Rice, a director, and manager of the San Francisco office, was elected President of the company. Mr. E. K. Robinson was re-elected Treasurer and Mr. E. N. Stevens, Clerk and Secretary.

Mr. Rice as President succeeds Mr. Henry H. Hilton who in his fifty-two years with the organization has played a leading part in its affairs. Mr. Hilton was Chairman of the partnership for some years and has been President since the incorporation of Ginn and Company in 1939. He will remain active in the company as Chairman of the Board.

Mr. Rice, the new President, was born in New Jersey. His early education was in the schools of New York City. After graduation from Cornell University in 1908 with Phi Beta Kappa honors, he became a graduate student, holding the Fellowship in American History in 1908–09. As high-school teacher and administrator in the State of Washington from 1909 to 1911, he gained his first experience in the field of public-school education. In 1912 Mr. Rice joined the staff of Ginn and Company's San Francisco office. For many years he was assistant manager of this office under Mr. Selden C. Smith and, on Mr. Smith's death, he became manager. In 1937 he was admitted to partnership in Ginn and Company. Mr. Rice is a trustee of Mills College, and he has been active in various civic affairs. He plans to move his residence from Berkeley, California, to Boston or its vicinity.

POISON WAR GASES

RALPH E. WELLINGS
Dorchester High School for Boys, Boston, Massachusetts

In these times it is more necessary than ever that everyone have a fundamental knowledge of the poison gases which have been perfected for deadly use or as harassing agents.

This article will give the reader the more basic facts about some of the common war gases together with data that should form the background in the subject for doctors, teachers, and lecturers on Civilian Defense.

To shorten the treatment, only chlorine, phosgene, mustard, lewisite and sneeze gas have been chosen for treatment.

Poison war gases are classified according to their physiological effects as follows: (the more dangerous persistent gases have been italicized)

I. LUNG IRRITANTS

Name	Army Symbol	Formula
Chlorine	CL	Cl_2
Phosgene	CG	$COCl_2$
Chlorpicrin	PS	CCl_3NO_2
Diphosgene		$ClCOOCCl_3$

II. VESICANTS

Mustard	HS	$(CH_2ClCH_2)_2S$
Lewisite	Ml	$(CHClCH)AsCl_2$
Ethyldichlorarsine	ED	$C_6H_5AsCl_2$

III. STURNUTATORS

Diphenylchlorarsine	DA	$(C_6H_5)_2AsCl$
Diphenylaminechlorarsine	DM	$(C_6H_4)_2NHAsCl$
Diphenylcyanoarsine	DC	$(C_6H_5)_2AsCN$

IV. LACRIMATORS

Brombenzylcyanide	CA	$C_6H_5CHBrCN$
Chloracetophenone	CN	$C_6H_5COCH_2Cl$
Ethyliodoacetate	KSK	$CH_2ICOOC_2H_5$
Tear Gas Solution	CNS	CN in PS and Chorloform
Xylyl Bromide		$CH_3C_6H_4CH_2Br$

V. Screening Smokes

White Phosphorus	WP	P
Titanium Tetrachloride	FM	$TiCl_4$
H. C. Mixture	HC	Cl_3CCCl_3
Sulfur Trioxide Solution	FS	SO_3HCl

VI. Paralysants

Hydrocyanic Acid	HCN
Hydrogen Sulfide	H_2S

A Brief History of Chemical Warfare

Thucydides described the use of burning sulfur and pitch in the Peloponnesian War. This burning mixture was called "Greek Fire."

1855—Lord Dundonald proposed to burn sulfur and allow the fumes to kill the defenders of Sebastopol. The English rejected the idea as inhuman.

1899—At the Hague Conference, the various governments pledged themselves not to use projectiles to diffuse harmful gases.

1907—At the Hague Convention, "It is expressly forbidden (a) to employ poison or poisoned arms. . . ."

1918—The Treaty of Versailles assumed that the use of poison gases in any form was contrary to international law.

1922—The Washington Conference held the above view.

The World War I

Oct. 27, 1914—Dianisidine chlorsulfonate was used at Neuve Chapelle unsuccessfully by the Germans.

Jan. 1915—Xylyl bromide was used by the Germans against the Russians.

March 1915—Benzyl bromide was used by the Germans. The toluol from which it was made was too costly as a source.

Apr. 22, 1915—Chlorine was used by the Germans at Langemarch against the French. Each cylinder contained 44 pounds.

Apr. 24, 1915—Chlorine used by the Germans near Langemarch against the Canadians.

May, 1915—The first respirator was issued to the English troops. It was a cotton pad soaked in $Na_2S_2O_3$, glycerine, and Na_2CO_3.

July, 1915—The Germans successfully used lacrimators in shells in the Argonne.

Sept. 25, 1915—The first British gas attack at Loos, using chlorine.

Dec. 1915—Phosgene was first used by the Germans.

Spring, 1916—The French used phosgene in shells at Verdun. At this time the French also used Acrolein. Chlorpicrin was used in hand grenades by the Russians.

July, 1917—The use of phosgene by the Germans in December 1915 found the allies protected. To overcome this protection arsenicals and mustard were used at this time. The Germans used mustard and diphenylchlorarsine at Ypres, Belgium.

Sept. 1917—The Germans used diphenylchlorarsine which passed through the filters then in use.

May, 1918—The Germans used diphenylcyanarsine.

1918—Lewisite was discovered by Capt. H. Lee Lewis of the U. S. Army. A shipment was being sent to France when the armistice was signed November 11, 1918.

Lung Irritants

GENERAL EFFECTS: All lung irritants affect the alveoli and bronchioles causing acute edema. Edema is the abnormal accumulation of serous fluid in the inter-fibrillar spaces of connective tissue or in the serous (peritoneal or pleural) cavities. With edema, breathing becomes rapid and panting and there may be danger of the patient suffocating in his own secretions. The alveoli may rupture, resulting in a concentration of blood. There may be a visible distension of the superficial veins of the face and neck. The lips, and gradually the whole face, may assume a cyanotic (bluish) tint.

The most severe case may be recognized by a lead-gray cyanosis of the face and rapid (120) pulse and cold, clammy skin. Death may come from failure of the circulation or from bronchopneumonia. If a case lasts into the third week the person may reasonably be expected to survive. In World War I, only 2.5% of the 350,000 gas cases that were hospitalized failed to recover.

Oxygen may be called for if cyanosis and pulmonary edema increase. No drugs have so far been found of value.

AFTER EFFECTS: Frequently there is an irritable heart and a sense of exhaustion but no evidence of heart disease. Spasmotic attacks due to nocturnal asthma may distress the patient.

CHLORINE CL Cl_2

PREPARATION: $4HCl + MnO_2 \rightarrow MnCl_2 + 2H_2O + Cl_2$ with gentle heating.

PROPERTIES: Odor of bleaching powder. Color, greenish-yellow. 2.49 times as heavy as air; therefore it seeps down into cellars, shell holes, trenches, sewers, etc.

Soluble in water: $H_2O+Cl_2\rightarrow HCl+HClO$

Bleaches: $HClO\rightarrow HCl+O$ nascent

Attacks metals: $Cu+Cl_2\rightarrow CuCl_2$

+burning sulfur: $2S+Cl_2\rightarrow S_2Cl_2\rightarrow S+SCl$

+burning phosphorus: $2P+3Cl_2\rightarrow 2PCl_3$. PCl_5 may form

Methane burns in Cl: $CH_4+2Cl_2\rightarrow C+4HCl$

+turpentine: $C_{10}H_{16}+8Cl_2\rightarrow 10C+16HCl$

+CO: $CO+Cl2\rightarrow COCl$ phosgene

+NaOH: $2NaOH+Cl_2\rightarrow NaCl+NaClO+H_2$

It is destroyed by an alkali spray or ammonia.

Detection:

$$6AgNo_3+3H_2O+3Cl_2\rightarrow 5AgCl+AgClO_3+6HNO_3$$

Note: By a careful study of the properties of a gas we are able to visualize what may happen if a gas permeates an industrial plant or the cellar or kitchen of a private home.

FIRST AID: Quiet, warmth. Treat the case as for broncho-pneumonia.

PHOSGENE CG $COCl2$ Carbonyl chloride

PREPARATION: $CO+Cl_2\rightarrow COCl_2$. In the presence of sunlight, the mixture is passed over animal charcoal as a catalyst. In this way Davy first prepared phosgene in 1812.

$$2CHCl_3+30\rightarrow 2COCl_2+H_2O+Cl_2$$

This second method is the oxidation of chloroform by chromic acid.

PROPERTIES: Odor of musty hay or of green corn. Normally a colorless gas. Soluble in organic solvents especially in toluene $C_6H_5CH_3$. Acts on metals in the presence of moisture forming metal carbonyls, e.g., $Ni(CO)_4$ and $Fe(CO)_4$.

Decomposes at 800°C.:

$$COCl_2\rightarrow CO+Cl_2$$

Decomposed by alcohol:

$$CH_3OH+COCl_2\rightarrow CO\begin{<}{Cl}{OCH_3}+HCl$$

forming methyl chloroformate. Or

$$2CH_3OH+COCl_2\rightarrow CO\begin{<}{OCH_3}{OCH_3}+2HCl$$

forming methyl carbonate.

Decomposed by water: $COCl_2+H_2O\rightarrow 2HCl+CO_2$

Rapidly attacks rubber.

$+NH_3$: $COCl_2+2NH_3\rightarrow CO(NH_2)_2+2HCl$ urea forms

$+NaOH$: $COCl_2+4NaOH\rightarrow 2NaCl+Na_2CO_3+2H_2O$

$+$phenol: $COCl_2+C_6H_5OH\rightarrow CO\langle^{Cl}_{OC_6H_5}+HCl$ forming

phenyl chloroformate.

$$COCl_2+2C_6H_5OH\rightarrow CO\langle^{OC_6H_5}_{OC_6H_5}+2HCl \text{ forming}$$

phenyl carbonate.

$+$sodamide:

$COCl_2+3NaNH_2\rightarrow NaCNO+2NaCl+2NH_3$ room temperature.

FIRST AID: Phosgene is nine times as toxic as chlorine. The irritation of the lower lungs causes chest pains. Acute pulmonary edema may result. Treat the patient as for chlorine poisoning. The gas may be destroyed by a spray of NaOH.

VESICANTS

MUSTARD HS $(CH_2ClCH_2)_2S$ Dichlor diethyl sulfide

GENERAL EFFECTS OF MUSTARD: Mustard gas affects all parts of the body but it is not a systemic poison. Moderate concentrations have no immediate effects and this is one of the dangers of the gas. The effects are delayed; symptoms appearing from two to three hours after exposure. The moderately severe case will present a typical appearance in twenty-four hours.

The blisters are red and are slow to heal, the skin becoming pigmented. The healing is slow due to the damage to the capillaries, veins, and lymphatics. The reddening of the skin is most marked in the genital region. Early nausea or persistent vomiting usually occurs accompanied by pain in the abdomen.

The devitalized tissues are easily injured by rubbing and become prone to infection. The lungs are especially subject to subsequent bacterial infection.

ACTION OF MUSTARD ON THE EYES: The eyes are the first parts to show the irritation. There is a smarting followed by lacrimation, intense pain, and headache. The eyelids swell and the cornea may become gray and hazy, losing its luster. Only a small number of cases sustain a total loss or even an impairment of vision.

PREPARATION: Dry ethylene is bubbled into SCl_2 at 40°C.

$$2\ \begin{matrix}CH_2\\ \|\\ CH_2\end{matrix} + SCl_2 \rightarrow S\begin{matrix}CH_2CH_2Cl\\ \diagup\\ \diagdown\\ CH_2CH_2Cl\end{matrix}$$

The German or Meyer's process used during World War I may be described as follows: ethylene is treated with HClO giving ethylene chlorhydrin $ClCH_2CH_2OH$. This is then treated with Na_2S giving thiodiglycol $S(CH_2CH_2OH)_2$ which upon treatment with HCl gives mustard.

PROPERTIES: Mustard is very slowly hydrolyzed by cold and more rapidly by very hot (boiling) water to form HCl and thiodiglycol (harmless). The gas is neutralized by the Cl in bleaching powder, by strong HNO_3, and by other strong oxidizing agents. Mustard is destroyed in the field by bleaching powder, CaClOCl. Food and water are rendered unfit for use by contact with the gas. Mustard has very slight action on metals—none on lead or aluminum. The gas may persist from one day to a week depending on the temperature, vegetation, etc. The gas may persist for several weeks in the winter.

FIRST AID: After the removal of all contaminated clothing, which is put into metal containers to be decontaminated, speed is essential in the treatment of the skin. Wash with soap and water, being careful not to become contaminated by the rinsings. The body is then washed with CCl_4 saturated with bleach solution of chlorine. The eyes are washed with either fresh or salt water every two hours.

FIRST AID FOR CONTAMINATION WITH LIQUID MUSTARD: Neutralize the mustard with bleach paste. Wash off the paste shortly to prevent skin irriration. This paste will aggravate the condition if reddening of the skin has already begun. This paste treatment will prevent blistering if it is given within a minute or two of contact with the gas. The paste may be prepared from chloride of lime and quicklime.

Another treatment is to swab the area repeatedly with an organic solvent which will dissolve but does not destroy the gas. The swab must be handled with forceps or the hands covered by rubber gloves.

The care of the eyes when they are hit by liquid mustard may proceed as follows: Wash the eyes every hour in plain water. The severity of the pain may be mitigated by using a 2% boric

acid solution after washing. If the pain is intense 1% atropine ointment may be used every twelve hours. Atropine, $C_{17}H_{23}O_3N$ occurs in belladonna and has a marked mydriatic action. Brown glasses or eyeshades relieve any photophobia. When the cornea is gray and rough a 2% solution of argyrol employed twice daily is useful. Argyrol is vitellin from egg yolk+Ag_2O. It is an antiseptic for the eyes and the mucous membrane of the throat. Frequent bathing or hot applications four times a day over the closed lids will relieve the pain.

Any laryngitis is best treated by a spray or by inhaling steam from boiling water containing a teaspoonful of a mixture of menthol and benzoin. Menthol, $C_{10}H_{19}OH$, is obtained from oil of peppermint. The formula for benzoin is C_6H_5COOH.

LEWISITE Ml $ClCHCHAsCl_2$ b-chlorovinyl dichlorarsine

PREPARATION: $C_2H_2+AsCl_2\rightarrow ClCHCHAsCl_2$.

PROPERTIES: The pure gas has no odor though it irritates the nose. If moisture is present or the gas is impure, it has the odor of geraniums. The gas is colorless if pure but darkens on standing to a brown color. It is more volatile than mustard gas. Since its boiling point is −13°C. it will be effective in cold weather when mustard gas will be a frozen solid. It boils at 190°C. and is, therefore, persistent. Lewisite is insoluble in water, but soluble in organic solvents. It is also soluble in oils and fats and therefore it penetrates the skin. It must be noted that the hydrolysis product is itself a vesicant solid.

Hydrolysis: $ClCHCHAsCl_2+H_2O\rightarrow HCl+ClCHCHAsO$. This compound is a white solid and a vesicant, hence it is dangerous, even after rain, to occupy an area gassed with lewisite. Since this hydrolysis is rapid lewisite is less suitable for ground contamination than mustard.

Very slight action on metals. Poisons food and water beyond decontamination. It is destroyed in the field by an alcoholic spray of NaOH.

$6NaOH+ClCHCHAsCl_2\rightarrow Na_3AsO_3+3NaCl+C_2H_2+3H_2O$

It is neutralized by Cl or strong oxidizing agents.

$+H_2O_2\rightarrow ClCHCHAsO(OH)_2+2HCl+O$

This compound is called chlorovinyl arsenic acid.

Note: Lewisite is really a mixture of three compounds which hydrolyze into:

Chlorovinyl dichlorarsine, $ClCHCHAsCl_2$

Dichlorovinyl chlorarsine, $(ClCHCH)_2\ AsCl$
Trichlorovinyl arsine, $(ClCHCH)_3\ As$

EFFECTS: Lewisite is more discomforting than mustard if inhaled and it is also more irritating to the eyes, skin, etc. There is usually a slight irritation in about fifteen minutes, followed by a gray discoloration and blisters in from thirty minutes to an hour. It is a systemic poison since it is an arsenic compound. Hence the blisters must be broken and the fluid evacuated. It is immediately irritating to the eyes.

FIRST AID: Wash the affected parts with soap and running water. Then the patient should be washed with a 5% solution of NaOH followed by alcohol. Keep the patient quiet and warm. Remember that the treatment must be immediate or much of its effect will be lost. Break the blisters because they contain arsenic. Do not use bleach water, NaClO, as for mustard, just wash with NaOH and rinse.

STURNUTATORS

DIPHENYLCHLORARSINE DA $(C_6H_5)_2\ AsCl$
SNEEZE GAS

PREPARATION: $2C_6H_6+AsCl_3\rightarrow(C_6H_5)_2AsCl+2HCl$

PROPERTIES: This gas has the odor of black gun-powder or of shoe polish. The compound is really a solid colorless crystal which vaporizes to a gray smoke cloud. Because of its high boiling point, 333°C. it is very persistent. It persists for about ten minutes in the open and from one day to one week in such a place as a sewer or cellar. The gas is insoluble in water but soluble in organic solvents and in phosgene, $COCl_2$.

EFFECTS: There is violent sensory irritation even in low concentrations. The symptoms are delayed for a few minutes but when they start they increase for some time. There is usually acute pain in the nose and sinuses and a feeling of fullness in the head. Sneezing takes place. Often there is a burning sensation in the throat and tightness and pain in the chest. There may be a feeling of grittiness in the eyes accompanied by considerable lacrimation. The gums may ache and nausea and vomiting may ensue.

The symptoms usually disappear in an hour or so. If water contaminated with the gas is taken internally there may be symptoms of arsenic poisoning. Such water may produce dermatitis if used for shaving.

FIRST AID: Complete rest is necessary. A little chloroform inhaled will help. The nose and throat must be irrigated. If no chloroform is handy, the odor of chlorine obtained from bleaching powder may be used. The gas is destroyed in the field by chlorine or bleaching powder.

DISCUSSING DIVISION BY 0

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Most teachers will perhaps agree that many high school students fail to understand the subject of division by 0. The purpose of this paper is two-fold: to show that the misunderstanding should not be neglected, and to outline one possible method of attacking the difficulty.

To show that something should be done towards enlightening the student, we can roughly classify pupils according to opinions they might hold regarding $1 \div 0$. There are three likely groups:

(1) Those who believe that $1 \div 0 = 0$, or that $1 \div 0 = 1$.

(2) Those who never considered such a problem, and have no opinion.

(3) Those who believe that $1 \div 0$ is impossible.

Students in group (1) can be confronted with the usual check of arithmetic division (divisor $\times$ quotient + remainder = dividend). This argument is, unfortunately, sometimes of only temporary benefit. It may be logically complete in disproving one statement, but it fails to provide an alternative. A pupil of the type involved is apt to revert to his first opinion. A more complete and constructive argument is advisable.

Students in group (2) need an awakening. Most of them encounter at some time the division axiom in some form such as, "When equals are divided by equals the results are equal, provided the divisor is not 0." It would seem that the qualifying clause should stimulate thought. If it does not, the pupil should not be permitted to remain unaware of the matter. Something should be done to show need for the ban upon 0 as a divisior.

Students in group (3) would at first glance seem to require little instruction. They have learned something. But have they insight in the matter? Somebody may ask, "Isn't an axiom always true, and if so why isn't the division axiom true when you di-

vide by 0?" The answer that we just don't divide by 0 is incomplete, for it merely leads to the question, "Why not?" When nothing further is said, the teacher abruptly dismisses a topic which has interested some of the best minds.

It would seem safe to conclude, then, that something should be done: to correct wrong ideas; to emphasize existence of a problem, and to develop insight while satisfying curiosity. A procedure intended to accomplish these things will now be outlined. The outline will be interspersed with relevant criticisms and comments.

First, division by 0 leads to incorrect results. We can employ the frequently used example:

Let $a=b$	
$a^2=ab$	multiplying both members by a
$a^2-b^2=ab-b^2$	subtracting b^2 from both members
$(a+b)(a-b)=b(a-b)$	factoring
$a+b=b$	dividing both members by $(a-b)$
$b+b=b$	substituting b for its equal, a
$1+1=1$	dividing both members by b
$2=1$	substituting 2 for its equal, $1+1$

This example interests most students, but is not sufficient in itself. The obviously incorrect conclusion must be explained in some way. But the student does not always feel obliged to accept the statement that the step involving division by $(a-b)$ (which equals 0) is the false one. If argumentatively inclined he may prefer to conclude that algebra leads to absurd results, and is therefore useless.

A second step in the procedure begins with the inviting of several students to suggest results for $543\div0$. Any result named can readily be disproved by checking. A more mature group of students can be shown the more general argument: If $543\div0=n$ then $0\times n=543$, which is impossible for any n. This step is powerful, and should be employed. On the other hand, it impresses some students as being essentially negative, and not as being a complete answer to the problem.

This leads to a third step which, if executed in sufficient detail, can be very effective.

$$1\div1=1$$
$$1\div.1=10$$
$$1\div.01=100$$
$$1\div.001=1{,}000$$

. . .
. . .
. . .

$1 \div .000001 = 1{,}000{,}000$

. . . and so on

$2 \div 1 = 2$
$2 \div .1 = 20$
$2 \div .01 = 200$
$2 \div .001 = 2{,}000$

. . .
. . .
. . .

$2 \div .000000001 = 2{,}000{,}000{,}000$

. . . and so on

Conclusion: For a given numerator, the smaller the denominator (so long as it be positive) the greater the quotient. That is, the closer we come to using 0 as a divisor, the greater the number we must write as a result. It is unreasonable to suppose that the actual 0 can be used as a divisor, just as it is unreasonable to suppose that there is a greatest number.

The student can be told that if he proceeds far enough in certain branches of mathematics he will learn more about very large and very small numbers, but that he will never actually divide 1 by 0. Algebra and arithmetic have certain rules, necessary if study is to be useful. Just as football rules won't permit the counting of a touchdown made with a stray golf ball, so mathematics rules won't permit a specific result for division by 0. It is necessary to have some rules, and reasonable ones are adopted.

Experience has shown that many students are sufficiently impressed by a discussion such as that outlined above to remember the essentials of the argument for several years. In particular, a student initiated in the ninth grade is at an advantage when he encounters the tangent of 90° in his study of trigonometry.

Some may believe that the whole subject should be avoided. Won't the student, in any event, have some doubts and some curiosity? Yes, but it is desirable to stimulate the imagination in a logical direction. The author believes that understanding of the idea of division by 0 is too incomplete, and that a teacher should take time to develop some student insight in the matter.

FOOD FOR THOUGHT

A One-Act Science Play about How Plants Get Their Food and What It Means to Us

VICTOR A. GREULACH *and* HELEN BARHAM
University of Houston, Houston, Texas

CAST OF CHARACTERS: Dr. William Greenleaf—(Professor of Botany at Midwestern University). A middle-aged man greying at the temples.

Robert W. Redwood—(Assistant to Professor Greenleaf). A graduate student, who is conservatively dressed.

Clark Dolittle—A freshman who is more collegiate than studious.

Mrs. Jones—A rather large, middle-aged housewife.

Junior Jones—(Mrs. Jones' son). An intelligent, but spoiled child of about seven or eight.

TIME: Early morning.

PLACE: Professor Greenleaf's office.

SETTING: A desk stands left front on stage, side to audience. On it there are scientific books, papers, journals, microscope, etc. Next to the desk and almost center rear is a chair facing the audience. Right rear is a long table containing a microscope, several boxes of microscope slides (one to be set near edge of desk), several open books, potted plants, plants growing in sand or water solution, test tubes, beakers, flasks, herbarium sheets with pressed plants, etc. A chair is behind both the desk and the table, and at right front of the stage there is a chair with an arm for writing. This chair faces left. Left rear is a bookcase in which there are books and biological equipment. Botany charts and pictures hang on the walls. Entrances are at left and right.

SCENE: As the curtain rises, no one is on stage. The assistant enters from the left carrying books and a box of microscope slides which he places on top of bookcase. He proceeds to inspect and water plants, straighten up his materials, etc. He is whistling as Professor Greenleaf enters right.

ASSISTANT REDWOOD: (*Looking up*) Good morning, Professor Greenleaf.

PROFESSOR GREENLEAF: Why, good morning, Bob. How are you?

ASSISTANT REDWOOD: Very well, thank you.

PROFESSOR GREENLEAF: How are you coming with those microscope slides you've been working on for use in connection with your thesis?

ASSISTANT REDWOOD: I just finished them, and they look pretty good to me this time. Would you like to see them? (*Obtains a slide from the box that is on the bookcase and replaces box, putting slide under the microscope.*)

PROFESSOR GREENLEAF: (*Walks over to microscope, looks into it and adjusts it.*) Say, you've done a good job on these! *Very* good, in fact.

ASSISTANT REDWOOD: Well, they'd better be. I must have tried a dozen times during the past six months to get some good ones, and I'd certainly hate to count all the hours I've spent.

(*Professor Greenleaf sits down at his desk, arranges his books and papers, and starts writing.*)

PROFESSOR GREENLEAF: Well, I hope I'll have a little time this morning to work on that paper I'm writing for the Academy of Science meeting.

(*A knock is heard at the door.*)

ASSISTANT REDWOOD: (*Going to door off right.*) Come in.

(*Dolittle enters.*)

PROFESSOR GREENLEAF: (*Looking up from his work*) Hello, Dolittle. What's on your mind this morning?

ASSISTANT REDWOOD: (*Aside*) Nothing, as usual.

DOLITTLE: (*Giving the Assistant a dirty look*) Morning, Sir. How about taking that make-up exam now? I'm all set to make an A for myself.

PROFESSOR GREENLEAF: Very well, let's see what you can do. (*Fumbles in desk drawer for the questions, and hands a paper to Dolittle.*) Here are the questions. Suppose you sit in that chair. (*Points to arm chair right front.*)

(*Dolittle sits down, and after glancing over the questions, gets out paper and pencil and starts writing. He remains here throughout the play, not entering in the conversation, but chewing gum vigorously, scratching his head, making funny faces, writing down answers, etc.*) (*A knock is heard at the door.*)

ASSISTANT REDWOOD: (*Going to door at left*) Come in.

(*Mrs. Jones enters carrying a flower pot containing a scrawny hydrangea plant which she shakes at the Assistant causing him to back across the stage. Junior follows.*)

PROFESSOR GREENLEAF: (*Rising*) Why, Mrs. Jones! I'm so glad to see . . .

MRS. JONES: (*Interrupting in a loud voice*) Professor Greenleaf, I'm so disgusted! For six weeks now I've fed this hydrangea more "plant food" and "plant nutrients" and . . . (*she ends lamely*) . . . well, just look at it! (*She shoves the plant directly at the Professor.*) What can I do about it?

PROFESSOR GREENLEAF: Well, Mrs. Jones, you'll probably think this is a silly question, but just what do you mean by plant food?

(*Junior wanders around room examining and handling various things on the Assistant's table. Mrs. Jones motions to him to come to her.*)

MRS. JONES: Excuse me, Professor Greenleaf, but what did you say?

PROFESSOR GREENLEAF: (*Offers Mrs. Jones a chair and the two sit down.*) I asked what you meant by "plant food"?

MRS. JONES: Oh, you know. You buy it in seed stores and such places. It is . . .

JUNIOR: (*In a very bored tone*) She means fertilizer.

PROFESSOR GREENLEAF: (*Both the Professor and Mrs. Jones give Junior a silencing look.*) Well, as a matter of fact, Mrs. Jones, fertilizer is not "plant food" at all.

MRS. JONES: It isn't? Well, then what good is it?

PROFESSOR GREENLEAF: Fertilizer contains various chemicals often called mineral salts, which are essential for plant growth and which are likely to be deficient in the soil.

JUNIOR: I didn't know you put salt on plants!

MRS. JONES: Junior! And just what are those chemicals, Professor Greenleaf?

PROFESSOR GREENLEAF: Did you take chemistry when you were in school?

MRS. JONES: (*With silly, shrill laugh*) I'm afraid it really took me!

PROFESSOR GREENLEAF: (*With patronizing laugh*) Well, those chemicals are nitrogen, potassium, phosphorus, sulfur, calcium, magnesium, iron and several others.

MRS. JONES: Are all these chemicals the only things plants get from the soil?

(*While this conversation is going on, Junior wanders up and down in front of the Assistant's table again, looking at the bottles, plants, etc., that are on the table.*)

PROFESSOR GREENLEAF: Yes, except, of course, water and possibly Vitamin B_1 in a few cases. In fact, plants can grow

very well without soil if they are supplied with water and all those chemicals mentioned. (*Turns to Assistant.*) Bob, show Mrs. Jones one of those plants growing in water and minerals. (*Assistant brings plant over to desk and Mrs. Jones inspects it.*)

MRS. JONES: Oh yes, I've been reading quite a bit about that lately, and they call the chemicals "plant nutrients." Now doesn't that show that they are really foods?

PROFESSOR GREENLEAF: Not at all. That term is another one which gives the wrong impression. The mineral salts themselves are not foods, but they are used by plants as raw materials in making certain foods.

MRS. JONES: But minerals are human food, aren't they? In my woman's magazine it said that minerals and vitamins were good for . . .

JUNIOR: Yea, Mama, remember the time you tried to reduce and . . .

MRS. JONES: (*In a very menacing tone*) Junior!

PROFESSOR GREENLEAF: (*Continuing*) Yes, Mrs. Jones, vitamins and minerals are often called foods, but you really can't stretch the definition of a food far enough to include them without getting into difficulties.

MRS. JONES: And just what is the definition of a food?

PROFESSOR GREENLEAF: A food is a substance which may be used by living things as a source of energy and as tissue building material. Only carbohydrates, fats and proteins meet both these requirements.

MRS. JONES: All of this is news to me. I always thought that plants got their food from the soil.

PROFESSOR GREENLEAF: Many people have that same idea. It is a very old one, going back to the ancient Greeks. Say, Bob, suppose you tell us that story.

ASSISTANT REDWOOD: The idea that plants get their food from the soil goes back, as Professor Greenleaf said, to the ancient Greeks. It was first disproved in 1450 by Cusaneus and in 1640 by a scientist named Van Helmont. He planted a weighed willow tree in a large pot containing a weighed amount of soil. Five years later he again weighed them and found that while the willow had gained 164 pounds, the soil had lost only two ounces.

MRS. JONES: That certainly shows that plants don't get food from the soil. But where do they get their food? They can't eat!

PROFESSOR GREENLEAF: They make it. Green plants when exposed to light under the proper conditions combine carbon dioxide, a gas in the air, and water from the soil and produce sugar. This process is called photosynthesis, which means—putting together by light.

MRS. JONES: Then plants will be undernourished if they don't get enough light?

PROFESSOR GREENLEAF: Exactly right, Mrs. Jones.

JUNIOR: Mama, can frogs and lizards make food—they're green?

MRS. JONES: Junior, if you don't be . . .

PROFESSOR GREENLEAF: (*Interrupting*) That isn't a bad question. You see, Mrs. Jones, it is not merely the presence of a green color that enables plants to make sugar, but the fact that there is present a particular green substance called chlorophyll which activates the process.

MRS. JONES: Oh, I see. But is sugar the only food plants use?

PROFESSOR GREENLEAF: No, indeed. Plants use the same foods as animals, that is carbohydrates, fats and proteins. The sugar made during photosynthesis is one of the carbohydrates, and all of the other foods may be traced back to it.

JUNIOR: I'll take steak and mashed potatoes.

MRS. JONES: Junior! It seems very strange, Professor Greenleaf, to think of plants using the same foods that animals do. But how do they use it?

PROFESSOR GREENLEAF: In much the same way that animals do—in building tissue, and as a source of energy. But most plants make more food than they use, so some of it accumulates in them. We sometimes use this accumulated food ourselves. (*Turns toward Assistant.*) Bob, suppose you tell Mrs. Jones about some of the important things we obtain from plants.

ASSISTANT REDWOOD: Our important foodstuffs such as wheat, corn, rice, and potatoes consist largely of the accumulated food of plants. We also eat leaves which contain little or no accumulated food. Even our dairy and meat products can be traced directly or indirectly back to green plants. Cows, for example, eat grass from which they make milk and steaks that we eat. As the Bible says: "All flesh is grass."

MRS. JONES: I never before realized just how much truth there is in that statement. Plants are certainly important, aren't they?

PROFESSOR GREENLEAF: You are absolutely correct, Mrs.

Jones. Besides, in the process of making sugar, oxygen is released by the plants. If this were not so, all living things would suffocate, if they wouldn't already be dead from starvation.

MRS. JONES: How terrible!

JUNIOR (*Shouting*) Everybody would be dead but me. I wouldn't be dead!

ASSISTANT REDWOOD: (*Aside*) I wish he were.

MRS. JONES: Junior!

PROFESSOR GREENLEAF: Then, too, don't forget all the items of commerce such as lumber, paper, rubber, cotton, and the various drugs and chemicals we get from plants and which can be traced back to the sugar made by photosynthesis. There is also at least one other important reason why plants are so valuable to man. Practically all the energy used in industry, transportation, heating our homes, and so on, can be traced back to the process of sugar making by green plants.

MRS. JONES: How interesting. I'd like to hear more about it.

PROFESSOR GREENLEAF: Very well. Remember that one sort of energy may be changed into another. For example, the chemical energy of coal may be changed into heat by burning, and the heat changed into mechanical energy by a steam engine. This may drive a dynamo which changes the mechanical energy into electrical energy, which may be changed into light by your light bulbs, into heat by your toaster, into sound by your doorbell, or into mechanical energy by things as unlike as your vacuum sweeper or a trolley car.

MRS. JONES: But I don't see what this has to do with plants.

PROFESSOR GREENLEAF: To begin with, practically all these chains of energy changes start by burning something.

MRS. JONES: Like coal or wood?

JUNIOR: Or your finger?

PROFESSOR GREENLEAF: (*Looking at Junior*) Yes, and gas, oil and gasoline—to name only the more important fuels. All of these fuels come from some plant or another.

MRS. JONES: Really? Of course wood comes from trees, and I know that coal was made from plants which grew millions of years ago, but what about gas, oil, and gasoline?

PROFESSOR GREENLEAF: They come from the remains of either plants or animals which lived long ago, possibly from both. In any case, we get back to green plants, for you recall that animals live on plants. So you see that just as in the case of

foods, all fuels may be traced back to the sugar made by plants.

MRS. JONES: Then all of our energy comes from the sun by way of green plants.

PROFESSOR GREENLEAF: Practically all of it, but not quite all. There are a few other sources such as water power, but they really supply very little of the total energy used. We must rely on plants for the great bulk of it; all the energy used by man and animals comes from plants by the way of food.

(*A crash is heard as Junior knocks the box of slides off the edge of the Assistant's desk. Professor Greenleaf and Mrs. Jones jump up and the Assistant groans.*)

ASSISTANT REDWOOD: My slides!!! (*Stoops to pick them up.*)

MRS. JONES: Junior, how many times will I have to tell you to quit meddling? (*To Assistant*) What has he done now?

ASSISTANT REDWOOD: (*With sigh*) Oh, that's all right. This was a box of old slides. I remember I put the good ones on top of the bookcase. (*Goes to get them and places them on the edge of the desk.*)

MRS. JONES: That's a relief. Junior! Come over here and don't you move again! (*Goes to get Junior and places him on the floor beside her chair.*)

PROFESSOR GREENLEAF: Now to get back to your hydrangea plant, Mrs. Jones.

(*Student rises from chair and walks over to Professor Greenleaf.*)

DOLITTLE: Pardon me, Sir, but I've finished my examination.

PROFESSOR GREENLEAF: Just give it to Mr. Redwood.

(*Dolittle hands paper to Assistant.*)

DOLITTLE: Whew! That was really a tough one!

ASSISTANT REDWOOD: (*Glancing over the paper*) Was number three too hard for you? I notice that you omitted it.

DOLITTLE: What was the question?

ASSISTANT REDWOOD: It says: "Where do plants get their food?"

DOLITTLE: Oh, I just overlooked that question. It's easy. Everyone knows that plants get their food from the soil.

(*Professor Greenleaf shrugs as if to say, "What's the use?" and Mrs. Jones smiles while Junior shakes his head solemnly. The Assistant is so disgusted that he lets his hands fall knocking the good box of slides off the table. He then covers his face with his hands and sinks into a chair with a loud groan.*)

Quick Curtain

A PROGRAM OF VISUAL EDUCATION IN THE EAST ALTON-WOOD RIVER COMMUNITY HIGH SCHOOL

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Visual Education embodies any and all means employed in instruction whereby the student learns primarily by the aid of materials.

As to the scope of visual education, the following visual aids may be included in this special field of instruction: photography, photoengraving, microscopy, flat pictures, charts, graphs, drawings, vocabulary cards, demonstrations, specimens, models, objects, exhibits, field trips, museums, metronoscopes, telebinoculars, and projectors.

The purposes in using visual aids are: (1) to supply a need for supplementary teaching, (2) to enrich and vitalize instruction, (3) to economize learning and teaching time, (4) to help develop proper concepts.

The value of any teaching aid depends not on its intrinsic quality, but rather upon the use made of it at a particular time and in a particular situation. The value depends also upon the extent to which it assists in achieving the objectives of instruction. Successful achievement of objectives depends greatly upon the presence of qualities in an aid such as accuracy, relevancy, realism, comprehensibility, and interest.

Two outstanding problems confront the teacher in using visual aids: (1) adaptation of the aids to the intellectual maturity of a particular group and (2) the realization of the greatest value possible from their use.

In the various classes of our science department this procedure is followed: each unit in the text is outlined for objectives, methods of presenting, directed study, and specific teaching aids for the unit.

Each teacher in the department plans his own use of the various aids available. Four centrally located stock rooms, one for each division of science taught, are within convenient access to teachers in this department. When equipment is borrowed from any stock room other than his own, that teacher leaves his initialed tag on the shelf or place assigned to that particular equipment. In that way equipment can readily be located.

Each teacher has a group of students, chosen for scholarship, dependability, attitude, and ability, to help set up apparatus, issue equipment, keep stock room in order, make minor repairs, assist in invoicing, and aid in general with the work connected in maintaining an efficient stock room. In return, these students are excused from certain outside assignments required of all other students. The experience, interest, and knowledge of the course content gained by these assistants very soon come to be recognized by most students and serve to create strong incentives to qualify for a place in this group.

Recently the Community High School agreed to cooperate with the Visual Aids Service of the University of Illinois in conducting certain experimental techniques in the field of visual instruction procedure. The plan is to prepare and distribute, to a special group of interested school people, certain materials related to the use of visual aids, in the hope that experimentation and development in improved techniques or methods of use of materials will be encouraged, and that production, collection, and assembly of visual materials in local schools will be promoted. This service will be in cooperation with the Museum and Visual Aids Extension Program of the Work Projects Administration for which the University of Illinois is acting as sponsor in the State of Illinois.

The proposed program will provide the following to the participating public schools: (1) briefs on past experimentation in the use of visual aids; (2) briefs on available materials; (3) briefs on production procedures; and (4) briefs on administrative procedures. The proper development of these briefs will require the cooperative services of school superintendents, principals, and teachers who will agree to act as consultants and be willing to carry out certain suggested experimentations within the limits of their physical abilities. Where definite experimental units can be set up, materials available from the Visual Aids Service Film Library or other sources will be supplied the cooperating school without cost other than transportation. Where a sufficient number of schools in any one county and the County Superintendent are interested, the experimental program may be instituted on a county-wide basis.

In the science department of the East Alton-Wood River Community High School the following visual aids are used: photography, under the direction of the Physics teacher and carried on through the activities of the Focus Club. Eligibility

to membership carries two prerequisites: (1) the student must be a science major; (2) he must be in his third year of science. There is a completely equipped dark room for use of the Club. Materials are issued at cost. This Club serves the school many times a year in providing pictures for many different occasions. Other applications of photography in aiding instruction are the construction and use of pin-hole cameras, blue prints, and color photography for studying such phenomena as protective coloration, the spectrum, and chemical changes.

It has been found that drawings and diagrams are more effective when they are built up by the teacher with chalk, adding each part with the development of each idea. This plan seems to be more practical and definitely less expensive than using charts purchased from a supply house. Illustrations of this fact actually proved are the teaching of floral anatomy, mechanical devices operated by water and air pressure, electrical circuits, and circulation of blood. In one of the General Science class rooms is a series of 53 diagrams depicting fundamental physical principles. These were done in white ink on black cardboard by students under the direction of the teacher. These diagrams, size 18″ by 28″ are fitted into slotted strips placed above the blackboards and may be arranged in groups as desired. The students may view them at any time, thereby reviewing principles readily and easily when occasion arises.

Vocabulary building has been definitely facilitated for students by the vocabulary cards which they prepare. As a new word or term is used in any topic, it is written, with its definition, on a 3×5 card; whenever possible a small picture illustrating the definition is cut from a magazine or paper and pasted on this card. Preparation of these cards may be done during supervised study time, especially at the beginning of the course, or as a student project or as a part of the daily outside assignment. It would be interesting, from a pedagogical standpoint, to devise and give a vocabulary test to two groups of students after they have finished the same science course under the same teacher, one class having used these cards and the other class having studied without them.

The lecture-demonstration aid is so well known and so widely used that it may seem trite to mention it. It is used in our introductory science course and also in advanced science courses when materials cannot be supplied to all or when it is not feasible to have the students experiment.

The importance of objects as aids is due to the fact that they are reality; the things themselves and not substitutes.

Exhibits have often served to stimulate interest in a topic because the student was able to come into more direct contact with the subject. There are various types of exhibits obtainable from industries, distributed for advertising purposes, which serve admirably to acquaint the student with materials which he otherwise might not come to know. Many of these exhibits are free to schools. Students, when stimulated and encouraged, have made some excellent displays which showed originality and use of leisure time.

The field trip is used to a limited extent in our school. In our community there is a wealth of material for trips. Such industries as oil refineries, a tannery, a steel mill, a munitions plant, a box-board plant, a glass factory, railroad terminals, and various others. However, very little use is made of these places for trips because of the limitation of time. Saturday mornings can not be used for these trips because of the varied interests and activities of the approximately 600 science students. Nevertheless, the trips in this area could aid the student after completion of his courses by providing him with some basis for vocational guidance.

Although the metron-o-scope and the telebinocular are most widely used in connection with the remedial reading program, the telebinocular, a diagnostic instrument, is issued to test any student suspected of having a visual difficulty. Formerly the Snellen chart alone was used; however, it is of limited value in spotting those cases with either slight or severe muscular imbalances that seriously interfere with visual functioning in reading. In our use of this instrument we do not feel that we are trespassing upon the field of the oculist. We do not make a diagnosis. Rather, we use our findings as a basis for our recommendations to a parent that a child be taken to a competent specialist for a thorough examination of the eyes at reading distance.

The metron-o-scope, a training instrument, is designed to help in the correction of undesirable reading habits arising from the improper use of the eyes in reading. This device is used daily in the remedial reading class.

The museum is housed in the biology class room. Its present status is due to the efforts of the unflagging interest of the biology teacher, aided by his students. For eleven years there has been a continual addition of material contributed by students,

purchased by funds, and by the teacher who has travelled extensively through the South and the West. The museum is an example which shows the benefit derived from interesting students in such a course as biology and directing their natural yen for collecting and hoarding.

Projectors enjoy wide popularity, due in part to a wide range of use and interest which they hold for students and in part to the fascination that an image offers. Projectors facilitate the direction of attention of a group to one thing at one time. The lantern slide, opaque projector, and film strip can present images that are steady, that can be held for as long as is necessary, and that can be shown as often as needed. The department owns about fifty 35 millimeter film strips, acquired by purchase and from free sources. Each strip has a series of 3×5 cards to accompany its presentation. Each card carries a typed explanation for each frame. Usually, when this aid is used, a student is given the strip and cards to study for presentation to the class.

The opaque projector uses all kinds of objects for projection. Materials from books and magazines can be used directly for group study; also any object that will cast a shadow can be used.

The motion picture is used for the following purposes: (1) to motivate, orientate, or give an overview of the unit, (2) to supplement the text; (3) to summarize and review the unit.

Motion pictures have several advantages not found in other aids. By this aid all parts of the world are brought to the class room. A brief survey of broad subjects can easily and quickly be made. Motion of objects which may never be actually seen can be shown. Activity is shown which no other pictorial aid can actually portray. Detailed study of processes and analysis of motion can be reproduced. Animated drawings can show action or objects which would be invisible to the unaided eye. The speed of motion can be controlled so that the speed of a bullet or other rapidly moving objects can be observed; action can be speeded up to the point where a normal life cycle of an organism can be presented on the screen in a minute, and the motion of a moving object can be stopped at any desired point for study. Altogether, the cost of an effective film program can be kept at a figure far below its actual educational contributive value.

However, the motion picture is not an ideal aid because it does have some disadvantages. It should be used only when situations call for motion to give the correct impression. An in-

animate object is better displayed by a slide, photo, or model. There is a possibility that the motion picture will be used as a substitute for, rather than as a supplement to other methods of presentation. Care also must be taken that the use of the motion picture does not relegate the teacher too much to the background. This aid requires a certain mechanical apitude which sometimes complicates matters. Furthermore, equipment is expensive and must be cared for carefully. Besides, there is the problem of securing films.

There are numerous sources of films available for instructional use. These sources may be grouped into three classes. Free, Rental, and Purchase. Each has its advantages. The use of free films does not require such an outlay of money as is necessitated by the school which purchases a film library. Furthermore, there are no films to become obsolete, to wear out or deteriorate, to require special storage and servicing. Free films, especially those sponsored by industry, are usually up to date and have a popular appeal. However, care must be taken to eschew films which contain objectional advertising. How often has the motion picture been taken by students (and adults) as a paragon of behavior. An instance of this is recalled when a film on a nationally known brand of antifreeze was shown science classes studying heat. The film fulfilled the desired purpose, namely to show that research on this product was important in maintaining its quality. However, the continual reference to the product's trade name had the effect of impressing the audience with the idea that this brand was the only absolutely reliable antifreeze on the market. Now many people of high school age like their questions and problems answered decisively and in as few words as possible. If they are told there is a "best" brand to buy they are happy because this relieves them from having to make a choice. In our community there are two internationally known refineries, each of which produces a good antifreeze. One of these refineries is the largest single contributor of taxes to our school district and has always played the part of the patron saint to the town. Let it be understood that in the name of fair play the teacher's finesse in using this particular film was greater than that of the producer's. Care also must be exercised to ascertain the existence of agreement between the teaching objectives and those of the sponsor when using a free film. The principal difficulty, however, in the use of any free film lies in securing the proper film at a time when it fits in best with class work. With rental

films we have had no experience. We have been able, when a motion picture was desired for aid, to obtain free films that served the purpose most satisfactorily.

About a year ago the Community High School considered a membership in a cooperative library for Madison County. Under this plan five schools, over a period of five years would purchase a total of 250 films at a cost of five hundred dollars to each school. However, the first year would give only fifty films for the use of these five schools at a cost of one hundred dollars per school. The next year fifty more films would be acquired and so on. During the school year we use about 120 films, secured from several distributors. We pay a service fee of fifty-five dollars and about thirty-two dollars postage, making a total of eighty-seven dollars for film service. This cost is less than that of a membership in a cooperative film library. We find that by using free films more and better films are obtained, the problem of transportation and scheduling are simplified, a greater choice of film subjects is possible, and the problems of film storage are eliminated.

Our film sources include the following distributors: approximately 50% of the films are from the Visual Aids Service, University of Illinois, 30% of the films are from the Y.M.C.A. Motion Picture Bureau, 10% of the films are from the Illinois State Department of Public Health, and the remaining 10% are from Advertisers.

Various types of films are used for classroom presentation: (1) that which illustrates one particular aspect. Its range includes an intensive study of one subject. (2) that which gives a rapid survey of an entire topic, aiding thereby in correlation and integration. (3) that which gives general information. This type enriches and expands classroom situations and aids in introducing a subject to which the teacher can devote little class time. (4) that which demonstrates a process, such as is used in industry. (5) that which demonstrates a skill. (6) that which dramatizes an event, such as a biographical study. (7) that which documents some social situation, such as a problem in public health. (8) that which gives background.

In selecting films, several points should be observed: The 16 millimeter film is the accepted standard size for classroom use. It gives sufficient brilliance and clarity of tone, even in long range projection such as is found in a school auditorium. The film should be self-explanatory, its length should not exceed a

half hour, and two or more unrelated films should not be shown together. Brevity of a film is desirable, since it allows time for a second showing during the class period and by its brevity avoids the stupefying effect on students that they experience with the double feature programs in theaters. Likewise, the film must be chosen for adaptation to the intellectual maturity and to the nature and extent of the students' previous experience. Much has already been said about the relative merits of sound and silent films. It has been our experience that the sound film is a powerful asset when depicting elements in which sound is an integral part of the situation. It is likewise helpful to those with reading difficulties. It brings a new personality to the class in the form of a new voice—a voice of authority that is synchronized with the idea presented. Furthermore, by this the teacher is saved time in preparation of an otherwise necessary explanation; an explanation which aids measurably a teacher who may be deficient in subject matter and lacking dynamic directive ability in the classroom. Occasionally a sound film may present a vocabulary problem. When this is the case, the teacher interprets the material in the light of the background of the class and fits his oral explanation to the vocabulary needs of the group.

Each teacher in the department selects films for his own classes. Selection is made by two methods: catalog descriptions and a card index system. The former is used when new and unfamiliar films are selected. The card index provides a 3×5 card for each film that has been used before. The information gives the title, distributor, length of film, catalog number, whether it is sound or silent, in color or otherwise, and comments pertinent to its usage. These cards are kept on file and grouped according to subject. In May these cards are distributed to the teachers for their guidance in making out the film lists for the coming school year. Eighty-five per cent of the films used during the school year are ordered in May of the previous year. This is advantageous since films are usually scheduled by the distributor according to receipt of order. In this way there is not so much chance of being disappointed by having to take undesirable booking dates. Each teacher indicates three choices of dates for each film ordered. Films are ordered from one source at a time. After the most important bookings are confirmed, an order is sent to the next most important source and so on. Thus open dates are fitted to the schedule

which may have been adjusted to any changes that were necessitated by the first source scheduled. This avoids throwing sequential teaching plans into confusion.

Furthermore, the majority of films are ordered from one source in so far as possible. The plan minimizes necessary clerical work, decreases the possibility of disappointments and assures better service from a distributor.

On each Monday the science classes are given a list of films and days that they are to be shown that week. This enables the students to arrange their time for study in all classes to better advantage, since no textbook assignments in science are given for those days. Also, the more enterprising students are able to use the library to obtain information in advance on the topics that will be shown them by the pictures.

If possible, the film should be previewed by the teacher, unless the film has been used previously and is familiar to the teacher. Some films have accompanying manuals from which the teacher can obtain a statement of the film's objectives, an outline of its subject, a list of activities to vitalize the subject, a bibliography, and questions for discussion.

Before showing a film, its purposes are listed on the board, with an outline of the topic presented. Sometimes questions are given to students to be answered from the facts obtained in viewing. If time permits, a preliminary discussion is held on what the students might know about the film's topic, but this has sometimes held but slight interest for them. Imminence of a movie tended to make them unresponsive toward any thing that delayed projection of the first flicker.

It is highly desirable to show the film in the classroom, beginning projection with the least possible loss of time and interruption following discussion. This means that the projector should be set up, the room darkened, and then artificially lighted before the class assembles. Occasionally more than one class requires the same film at the same time. When this is the case, extra stools are brought in by the visiting class. Attention, however, is less concentrated with this arrangement.

After showing the film, any questions that students have are answered, by the teacher, or preferably, by other students. Often, however, these questions may be better answered by another showing.

In evaluating a film, the following points are to be considered: Introductory shots for orientation. Good lighting and definition.

"Soft focus" may be suitable in dramas, but for science it may leave puzzled concepts as fuzzy as the focus. Also the light should not vary unless the nature of the shot calls for such. There must be sharp illumination but not to the degree causing eye strain. Important shots should be close-ups. Good pictorial composition and background are highly desirable. Still material is to be used only where absolutely necessary. Attention directing devices such as arrows, circles, are to be used when needed. An excess of optical devices such as wipe-outs, fade-outs, and angles is to be avoided. Scene length must be sufficient to insure mental assimilation. Scene changes should be done smoothly. Animation should be smooth, skillful, and accurate. Simplicity of material is desirable to illustrate points. Familiar objects, in most cases, should be used for purposes of comparison of size, weight, etc. Masses of details are to be avoided. Narration must be pertinent and interesting; voice to be clear and pleasant. Film must present something that is accurate and real; avoid the spectacular at the expense of accuracy and reality. It must be emotionally suited to the grade level. Film should lead to desirable interest and appreciation. Student reactions and opinions are well worth consideration, for they are the ones who are to benefit—profitably, if the film is a success.

Sources of Information on Visual Aids may be obtained from texts, such as:

Dale, Dunn, Hoban, & Schneider—'37—*The Motion Picture in Education*
Hoban, Hoban & Zisman—*Visualizing the Curriculum*
McKown and Roberts—*Audio-Visual Aids to Instruction*
Heiss & Obourn—*Methods of Teaching Sciences*
Miller and Blaydes—*Teaching Biological Sciences*
Dent—*Handbook on Visual Aids*

Catalogues, such as:

Y.M.C.A. Motion Picture Bureau
U. of Illinois
Victor Co.
1001 Films—H. W. Wilson Co., N. Y. City

Journals & Magazines:

Educational Screen (div. of N.E.A.)
Filmo
Film News

Conclusions

No one visual aid is best, but the motion picture seems to be the most popular. The usefulness of any aid is specific and varies with the topic. A closely correlated aid, especially the projector type, is efficacious because of two ever present variables: Namely, the individual difference in human beings and the variable difficulty of subject matter. Teaching efficiency is undoubtedly greater with the use of visual aids. Learning efficiency is likewise greater with these aids. Exposure, however, to visual aids is by no means a guarantee of successful teaching. Rather, the results are what determine a guarantee. Each unit should be studied with the purpose of using as many different aids as are feasible for vitalizing the unit. Each department of our school has its own methods for using the various aids, with a teacher in the science department who acts as a director of visual education for the school. A committee of three teachers works with him. This director compiles visual aid sources, previews, evaluates and assists in the selection of films, slides, and film strips, acts as advisor and coordinator in booking and scheduling films, gives instruction in the use and care of equipment, schedules operators, supervises them, keeps records and makes reports to distributors and principal, returns films on designated dates and aids in planning and spending the visual aids budget. Once a teacher becomes interested in using visual aids, his enthusiasm for their value will lead him to be ever alert in discovering new sources of materials and in adding to his collection of these.

"WARMER-UPPER" FOR PLANES

If American fighting planes next winter have to operate under Siberian conditions, either in Alaska or Iceland, or even on a North European front, they can have the services of a warming-up cruiser truck to rid them of snow and ice and get the temperature of their engines up to a safe starting-point, if the invention on which patent 2,273,502 was granted to Kibbey W. Couse of Newark, N. J , is adopted for Army use.

It consists essentially of a truck with a tent-like arrangement attached to its rear end, with a blower to pour out a stream of warm air. The air is warmed by the engine radiator, with a stove burning any kind of fuel to supplement it where necessary. Within the truck is a small, compactly arranged machine shop, also kept warm so that the mechanics may work more rapidly and efficiently. There are even warming lines to individual tools that may be needed for work on outside parts of the plane.

CRITERIA FOR SELECTING SCIENCE BOOKS

HUBERT J. DAVIS
Matthew Whaley School, Williamsburg, Virginia

We have overemphasized facts in organizing our science courses of the past. Each course has been a miniature or abbreviated college course. Now we are swinging toward a more functional organization around the daily experiences of our pupils. We are giving them numerous exercises to train them in the use of the scientific method, and to develop the scientific attitude. The tendency to do, rather than to read; to gather materials through first hand experiences rather than from printed materials, is certainly a step forward. Quite often the authors of our textbooks have led the way, and very few books lag behind new developments in teaching. Now the new approach to science as revealed by the textbooks, is from the practical to the more technical in the high school book, and just the opposite in the college book.

We may class our science books under the three main groupings of textbook, tradebook and reference or encyclopedia.

The textbook differs from the others in that it is designed to be used by the teacher for instruction with the expectation that each pupil in the class will have access to a copy. It is usually organized to proceed from the unknown to the known and related topics. It treats primarily of one field. It is usually indexed, has a table of contents, and a list of supplementary references which are to be used for further study. It contains learning exercises, previews or overviews, and illustrations and diagrams. It is written with the purpose of providing enough materials to cover either a semester or a whole year of work. Often it contains far more materials than would be expected to be covered by any class, the additional material being supplied for the more alert or advanced pupils of the class.

The trade book is not written to be used as a textbook. It attempts to permit rapid and interesting reading. It may be either broad, giving an account of the wonders and spirit of science, or narrow, covering some specific area, such as transportation, or aviation. Interest is primary in the trade book, yet it is designed to instruct as well as to entertain. Its style is always informal. It does not provide teaching aids. The physical make-up is different from the textbook in that it is written on cheaper paper, and has a less secure binding.

The reference book has no definite style, and usually places emphasis on conciseness and preciseness. However, there are some exceptions to this feature, such as Compton's and others. While the trade book is written by one author, the textbook by one or more, the encyclopedia has many authors, with each a specialist in his own field and each usually having a different viewpoint. It may contain specific information on some or many topics, or it may be encyclopediac in nature and try to encompass all of the known knowledge man has assembled in one, or in all fields.

Science books are likely to be shortlived. They soon become obsolete because of the rapid developments brought about by research in science. There are some science books which are classic, however, and are never out of date, but are reprinted from year to year. Such books as *Sound and Light* by John Tyndall or *Origin of the Species* by Darwin, will be read for generations to come. The same is true of many standard works on insects, flowers, geology, birds, and other fields where research is not likely to bring about much change.

Each year a large number of science books is written. This number may vary from two to three hundred. There is always a large number of new science textbooks. For example, in the period from 1920 to 1925 there were one-hundred and seventeen new high school chemistry textbooks.

There are a few objectionable tendencies which we must guard against when we select our textbooks. Some science textbooks have been written for the express purpose of providing materials for the duller pupils who cannot comprehend some of the deeper scientific principles. There are a few instances where these books have proven to be popular, and the publishers have emphasized them for use by the whole high school class. Some of these books have outlined courses with a minimum of laboratory work and demonstrations. These have, in some cases, become quite popular with the short-sighted, financially pressed administrators who found an opportunity to have science courses organized with a minimum expense for equipment and supplies.

Each year more emphasis and more space is given to the topic of consumer education. We must apply the same scientific attitude of critical evaluation to these books as we do to the consumer problem, lest we prejudice our pupils, and impart to them a "consumer beware" attitude.

Occasionally a publisher will attempt to republish a book in which the chapters have been regrouped under convenient unit headings, a few pictures have been added, the type enlarged and other physical changes made. Such deceptive undertakings should, and usually do end in a merited failure.

Too often our science books, as well as other textbooks, are written in language too difficult for the pupils to read. If we are going to teach science concepts, what is wrong with giving the pupils materials which they can both understand and enjoy?

The moving picture, demonstration experiment, field-trip, pupil-project, radio, current scientific periodicals, pupil-activity units and other devices have gone far toward releasing the pupil from the shackles of the textbook of a few years ago. In spite of all of these new teaching aids, the textbook is yet, and probably will remain the chief source of materials. It is still the most used tool. Therefore, with so many books to select from we should make the selection carefully. Some specific criteria for selecting high school science books are given below.

I. Physical Makeup

1. Physical Appearance
   Attractiveness, beauty, harmony of color.
2. Physical dimensions
   Thickness—if too thick the binding is easily broken
   Size—If it is too long or too wide it may be too big to fit into shelves and cabinets.
3. Date
   Because research and new developments make science books obsolete, the copyright and revision dates are very important.
4. Binding
   Strength, durability, and attractiveness.
5. Print.
   Large clear type, proper spacing, good paper.
6. Illustrations
   Appropriateness, beauty, up-to-date, with sufficient diagrams, tables, and charts.
7. Cost
   Should be in porportion to the make-up and to the materials it contains, such as pictures, tables etc.

II. Materials of the Book

1. Scientific principles
   Theories and laws well presented in understandable language.
   Theories and laws not to consume too much space.
2. Descriptive materials
   Written interestingly and effectively
   Not encyclopediac in nature
   Not enough new terms introduced to confuse the meaning and discourage the reader.

3. Illustration of principles
   Experiments which are described well and chosen for the principle involved.
   Demonstrations which are practical, and simple enough for the slowest pupil to understand.
4. New principles and discoveries
   These given proper consideration.
   Sufficient explanation.

III. Professional Materials

1. Tests and reviews
   Self testing exercise.
   Well directed and graded review questions.
   New type tests used for stimulation of pupils.
2. Interest
   A definite attempt made to arouse pupil interest.
   A conscious effort made to hold pupil interest.
3. Interrelationships in the fields of science
   Due appreciation of all of the fields of science.
   Bearing on any principle or problem.
4. Emphasis
   Proper emphasis given to topics.
   Methods of securing this emphasis pedagogically sound.
5. Study outlines
   Challenging and suggestive.
   Relate student activities to daily experiences.
   Reference materials cited.
   Visual aids cited.
   Suggestive home demonstrations or experiments.
6. Subject materials
   Historical treatment.
   Vocational materials.
   Biographical materials.
7. Teaching aids
   Tables.
   Indices.
   Problems.
   Bibliographies.
   Lists of standard tests.
8. Objectives
   Real and practical.
   Selected so as to develop scientific attitude.
   Clearly stated.
   Realized through the unfolding of the materials in the book.

Each year there are so many new trade books published that it is impractical for the science teacher to review even a small number of them. The busy teacher cannot keep up with the individual reviews which may be published in many periodicals at different times throughout the year. Therefore, it becomes necessary to rely upon authoritative reviews or digests, and book lists.

There are many such sources of information. One of the best, I think, is the cumulative list which is published each fall in the *Peabody Journal of Education*. This review and classification of science books has been worked out for the past fifteen years by Dr. Hanor A. Webb, and is quite reliable.

Each year the leading publishing houses send him a copy of their new science books which they consider distinctly on the high school level. This amounts to from two to three hundred books. These books are first classified as to their field, then as to their merit, then as to price range. The best books, those considered by Dr. Webb as indispensable to any libarary which has as much as ten dollars to spend for books are put in his ten dollar list. Five dollars worth of the next best are added to this to make the fifteen dollar list, then ten dollars worth of the next best are added to make the twenty-five dollar list and so on up to three-hundred dollars. Reprints of this book list are available through Dr. Hanor A. Webb, *George Peabody College for Teachers*, Nashville, Tenn.

RADIO "HAMS" ASKED TO SELL THEIR EQUIPMENT FOR WAR USE

Radio amateurs are being called upon by the American Radio Relay League to sell their transmitters and receivers for use by the armed forces of the United Nations. Manufacturers are unable to fill the need under present circumstances. Only standard manufactured equipment is needed. Homemade or "composite" equipment is not required at present.

The greatest need is for transmitters, the League stated. According to their figures, only 5% of amateur transmitters were purchased from manufacturers, while two-thirds of their receivers are factory-made.

SULFANILAMIDE AN AID IN SAFE TOOTH EXTRACTION

Extraction of teeth of patients with valvular heart disease can be accomplished with the aid of sulfanilamide without the risk of causing an often fatal heart ailment, subacute bacterial endocarditis. Dr. Joseph A. Hopkins of St. Anthony's Hospital, Rockford, Ill., reported these findings after study of the use of sulfanilamide in dental surgery.

Dr. Hopkins explained that the germ which causes this type of endocarditis—Streptococcus viridans—is present in the throats and mouths of even healthy persons. The germ does not enter the blood stream, however, unless there is a break in the mucous membrane such as would be caused by pulling a tooth. Once in the blood stream the germ may attack the weak spots of the heart.

By giving patients sulfanilamide, this danger is eliminated since the germ is killed before it can cause trouble, he concluded.

NOTES FROM A MATHEMATICS CLASSROOM

JOSEPH A. NYBERG
Hyde Park High School, Chicago

(*Continued from the March issue*)

11. Directions for Solving Verbal Problems. An interesting study could be made of the directions found in algebras for solving verbal problems. Most of the directions begin with "Read the problem carefully." This is rather useless advice since even the most careless reeader believes that he reads the problem carefully. For many years I wrote various directions, submitted them to the class for criticism, and tried to find that much desired "best" set of directions. I also tried the following experiment.

Sometime during the third or fourth month of algebra, after the class had had some experience with problems, I asked each pupil to write some advice just as he would give it to another pupil who was having difficulty with these problems. I selected the best essays, and the following year, after the class had again written similar essays, I passed out to the class the directions written by previous classes. Then the pupils rewrote their advice. Thus each class combined its experiences with those of previous years. Finally there evolved an essay which I submit here because it is entirely different from anything which appears in any textbook. It reads about as follows:

"Every problem involves a lot of numbers. Some of the numbers we know; these are called the data in the problem. Some of the numbers we do not know; these are called the unknowns, and we are asked to find them. Until we do find these unknown numbers we pretend to know them and call them x or y or some other letter. From the numbers that we know and the ones that we pretend to know we can write expressions for other numbers.

"To find the unknown numbers we must have an equation. An equation merely states in an algebraic way some information about the numbers. Sometimes this information is stated in the problem. Then the problem is easy. The hard problems are those in which the information is not stated in the problem but you are expected to know it, such as

distance equals rate multiplied by time;

the amount of work A does equals the number of hours he works multiplied by what he does in one hour;

the value in cents of some nickels equals five times the number of nickels;

n years from now we will all be n years older."

If the reader smiles at the last remark let him consider how many problems the pupils have missed because they did not make use of some such obvious fact. The pupil easily learns that certain numbers should be called $2x$ or $x+3$ or $10-x$. It is more difficult to discover the relations which are not stated explicitly in a problem—those relations which are not stated explicitly because the pupil is expected to know them or be able to find them. After finding these hidden relations, the pupil is asked to record them in a notebook. The class makes a collection of them. Here are some of the examples we have recorded. Parents would be amused at the seemingly trivial nature of these statements:

If a man travels from A to B and returns over the same road, the distance from A to B is the same as from B to A.

What you have added to what somebody gives you will be the amount you then have.

The income from one investment added to the income from another investment is the income from the two investments.

The amount of work A does added to the amount of work B does is the amount of work they both do.

The value of some corn added to the value of some wheat is the value of the corn and the wheat.

The number of gallons of butter fat in some milk added to the number of gallons of some butter fat in some more milk is the number of gallons of fat in both.

The minute hand of a clock travels twelve times as fast as the hour hand.

If two boys run around a circle in the same direction until the fast boy catches up to the slow boy, the fast boy will have run one more lap than the slow boy.

Note that none of the above facts is ever mentioned in a problem but the pupil is expected to know them. Hence the pupil's essays end with some advice like: If you can't solve a problem look for some simple relation between the numbers; if you can't find it, make up a simple arithmetic problem that uses the same numbers, and study it.

12. Quotable Reasons in a Geometric Proof. Textbooks emphasize that any reason quoted for a step in a proof must be an axion (postulate), definition, or a previous.ly proved theorem (or corollary). But teachers disagree on their choice of theorems.

Some teachers limit the theorems to a short list so that the pupil can remember what is or is not a theorem. Other teachers do not care how long the list is; they feel that if a pupil has at some time proved a theorem he should be allowed to quote it even though at the time the pupil may be unable to reproduce the proof. I belong to the second group. The great number of my quotable theorems is due to my attitude toward all generalizations.

For example, suppose the class has worked the following exercise: If, in triangle ABC, $AC=BC$, and AD and BE are angle bisectors, then $AD=BE$.

Then, if asked to generalize what has been proved, some pupil will say: The bisectors of the equal angles of an isosceles triangle are equal.

Again (to show how the same idea can be applied to less important exercises) after prolonging the median AD of triangle ABC to E, making $DE=AD$, and proving triangle CDE congruent to triangle ABD, the class can make the generalization: If a median of a triangle is prolonged its own length, and the end point joined to one of the other vertices, the pair of opposite triangles are congruent.

A great deal might be written about the importance of generalizing, not only in mathematics, but in all fields. The geometry teacher should not neglect it. If any exercise can be generalized without being too verbose, I try to have the class do so. My object, however, in this note, is not to discuss the importance of generalizing but to point out that if the teacher does much work of this kind, then the teacher must also permit the class to *use* the generalizations that the class develops. The value of the work must not be impaired by forbidding a pupil to quote the generalization whenever he is bright enough to see its application. From this point of view the number of reasons that may be quoted is greatly increased.

Some teachers contend that if this procedure is adopted the pupil becomes careless, often quoting merely a generalization of the very thing he is being asked to prove. This trouble is easily corrected. The pupil should be complimented for his ability to see the generalization (ability to generalize indicates high intelligence) and should then be asked to prove that generalization.

Should a pupil be allowed to quote an exercise? Again I say, "Yes, if the exercise is stated as a generalization." If the pupil

is bright enough to recall the exercise, and see that it can be used, he should again be complimented. In after-school life we solve our problems by collecting all possible generalizations germane to the problem.

Once upon a time college entrance examination boards and other examining bodies felt that they could not determine a pupil's knowledge of geometry without restricting the number of quotable reasons or knowing from what textbook the pupil has learned his geometry. But so much cleverness has now been devoted to the construction of examinations that this objection no longer applies.

13. A Question for the Pedagogy Class. Apprentices often waste much time in class when correcting an error made by some pupil. The difference between an experienced and an inexperienced teacher is obvious in such situations. The former can correct the error is a few words if the error is trivial, or call the attention of the class to its significance if it is important. Classes in pedagogy could well afford to discuss some typical situations like the following:

A pupil in a geometry class is discussing a figure in which the point C is equidistant from A and B; E is a point on AB. The pupil states that CE is the perpendicular bisector of AB giving as his reason: If a point is equidistant from the ends of a line, it is on the perpendicular bisector of the line.

What should the teacher say? Would you devote one, two, three, or how many minutes of class time to discuss the error? Is the error significant? Often a pupil's error can be used to introduce some new topic in logic; is the above error of that variety? The teacher's treatment of the error would depend also on whether the error was made during the second, third, fourth, or a later month; how would the teacher's answer differ when this fact is considered? How does the teacher's answer differ if E is not any point on AB but is the mid-point of AB?

SAFETY PONTOON FOR SUBS

What its inventor, Benito Rivera of Philadelphia, describes as a "signal pontoon for submarines" is the subject of patent 2,273,497. It is a large sphere, capable of being released from a sunken submarine. It would carry one or two men to the surface, where they could signal for help and cooperate with the rescuers when they arrive. An important feature is a pair of hose lines leading back to the submarine, through which fresh air could be piped back to the imprisoned crew.

THREE PHASE DEMONSTRATION GENERATOR

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Here is a demonstration assembly built mainly from the coils taken from several discarded door bells. It illustrates the working of a three phase A. C. generator of the rotating field, stationary armature type.

The armature consists of a circular piece of iron about 14 inches in diameter, inside of which are mounted 18 coils. Each third coil is joined in parallel with the other five in such manner that the induced currents from all six will be in uniform phase.

Then the six coils to the right and adjacent to these are joined in parallel in like manner, and so also are the remaining six.

The three sets of two wires are brought out from the base of the ring to conduct the currents from the three phase system of coils.

To emphasize the fact that the three sets of coils constitute three separate systems or circuits, the six of one circuit are painted red, the six of the next circuit, white, and the third set of six are painted blue, so that the coils alternate red, white, and blue.

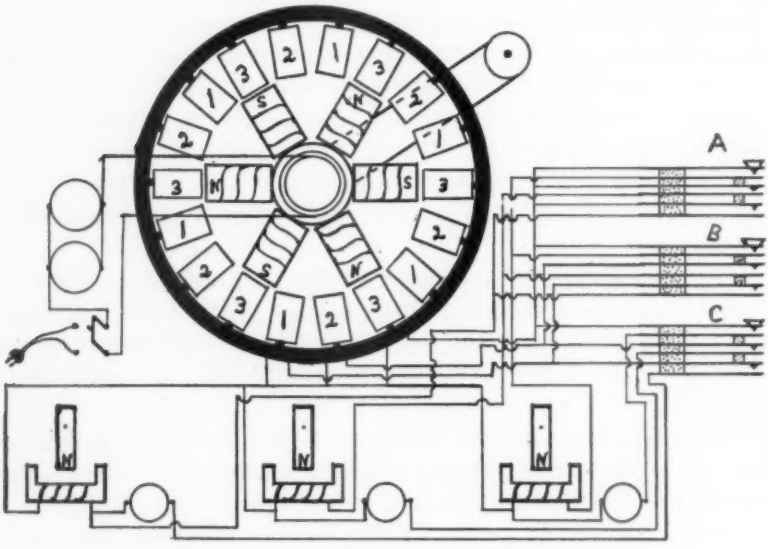
On a shaft mounted to rotate at the center of the armature are set six coils with 60 degree spacing. These are wound with fairly heavy wire, No. 22, and are all joined in series in such manner that when a current is sent through them the outer poles alternate N. and S. To give the correct impression of the polarity of the rotating coils, three of the alternate poles have been painted with aluminum paint and the other three alternate poles are painted with bronze paint. The two ends of the wire leading to these coils are joined to two slip rings, with brushes set to lead in the current.

Connection to a 110 volt D. C. line is made through a heating coil and a 120 watt lamp in parallel, so that five amperes or more can be passed through the field coils. This heats them quite rapidly but for demonstration the current would be used for only short intervals and with care the coils may be kept from overheating. A crank is attached to the shaft so that it may be rotated by hand.

In front are set three small electromagnets, U shaped, and

each about one inch wide with poles projecting a half inch above the coils. They are wound with three layers of wire large enough to offer little resistance. These magnets are set in line and spaced so that the three are clearly visible and the wires from these are connected to six point switches, *A*, *B*, and *C*.

Each switch is made of spring brass strips supported near one end so that they are insulated from each other, and mounted one above another. They are built from reassembled jacks out of old radio sets. Each group of two is also insulated from the adjacent two near the unsupported end.



When a button on the top strip is pressed lightly, contact is made between the upper two. By pressing harder, the middle two also make contact, and when the button is pressed clear down the lower two also make contact.

The wires from one set of the armature coils are connected through tripple key *A*, to the three demonstration magnets so that when the key is pressed clear down the three are in parallel.

Mounted above each magnet is a piece of magnetized clock spring, about two inches long but with the upper end bent in semicircular manner, and pivoted along the diameter of the semicircle, so that the pivot is only a little above the center of gravity, giving the swinging magnet a quick response to changes in the electromagnet. The springs are so magnetized that the

lower ends are all north poles, and these are painted with white enamel. The poles of the electromagnets are covered with thin rubber so the swinging magnets may not actually touch them.

When the field is excited and rotated slowly and switch *A* pressed lightly so as to close the circuit of one magnet only, the swinging spring above that magnet vibrates to the right and left in step with the speed of alternation of the current. If then the switch is further depressed, a second magnet is excited and these two springs swing in unison. When the key is pressed clear down all three springs are made to swing in unison for the currents in all three magnets are in the same phase.

Through triple key *B*, of the same kind as above described, the three separate armature circuits are connected to the three separate magnets so that when the key of this switch is pressed lightly, one spring starts swinging. If further depressed the second contact is made and the second spring also starts swinging, but not in step with the first. And if the key is pressed clear down the third contact is made when the third spring also swings, but out of step with the others, giving some conception of the three phase idea.

To make this visible in a slightly different manner, three small 1½ volt lamps are mounted in front of the three magnets and these are connected through triple key *C* to the three armature circuits. When this key is pressed lightly one of the lamps flashes as the field is rotated. With further depression, first two and then all three of the lamps flash but not in unison as each is a third of a cycle out of step with the other two.

The iron ring was prepared in our manual training shop from a strip of ¼ by 1 inch iron. The mounting for the rotating field together with the shaft and slip rings are a part of an old discarded piece of apparatus.

"SAFETY" LIQUID OXYGEN BOMB

A new effort to make use of the known violent explosive properties of liquid oxygen when mixed with combustible substances is represented in the invention patented (no. 2,273,166) by R. C. Allen of Sherburne, N. Y. One objection to many previous attempts along this line was that the bombs became dangerous to the user long before they could be dropped on the enemy, because the liquid oxygen and the combustible were mixed at the outset. Mr. Allen obviates this by keeping liquefied combustible gases and liquid oxygen in separate compartments, which are shattered to mix the deadly ingredients just as the bomb strikes.

DEMONSTRATING THE ECLIPSES

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As a result of the present state of world affairs there will be many globes to be discarded by school geography and social studies departments. With extensive changes in political boundaries, these teaching aids become useless to the above mentioned departments, but in the hands of enterprising science club members they can be converted into excellent demonstration equipment. Several coats of aluminum paint (white paint will serve the purpose in the interests of national defense) will give a globe a good reflecting surface for demonstrating phases of the moon, eclipse of the sun and eclipse of the moon.

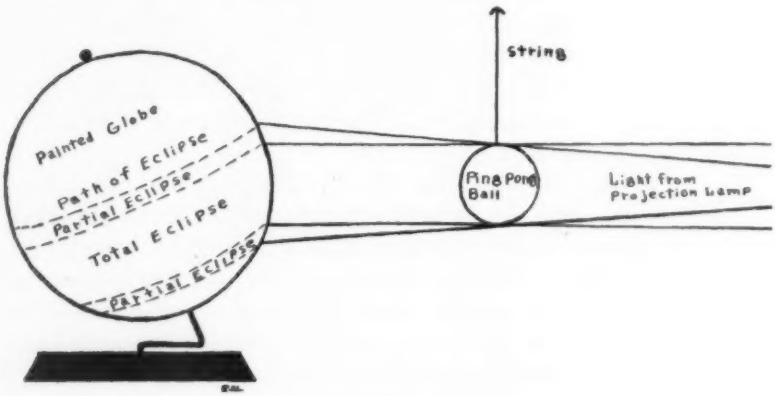

FIG. 1. Eclipse of the sun.

The eclipse of the sun may be demonstrated by illuminating a painted globe (earth) with light from a projector and then moving a painted ping pong ball (moon) across the space between the projector (sun) and the globe. (See Fig. 1.) The bodies should be so adjusted that both a heavy shadow for total eclipse and a light border shadow are cast. The light shadow at edge of dark shadow will represent the area of partial eclipse. While one student is moving the ball across the space another one can slowly rotate the globe on its axis and trace with charcoal the path of the eclipse as it moves over the surface of the globe. The areas of both partial and total eclipse should be traced and then later shaded in so as to give a complete picture of the effect of the shadows on the earth's surface.

Total and partial eclipses of the moon may be shown by lighting the surface of the globe and then passing the ball (moon) into the shadow of the globe. (See Fig. 2.) By watching the ball as it passes into the shadow, the eclipse can be seen to spread across

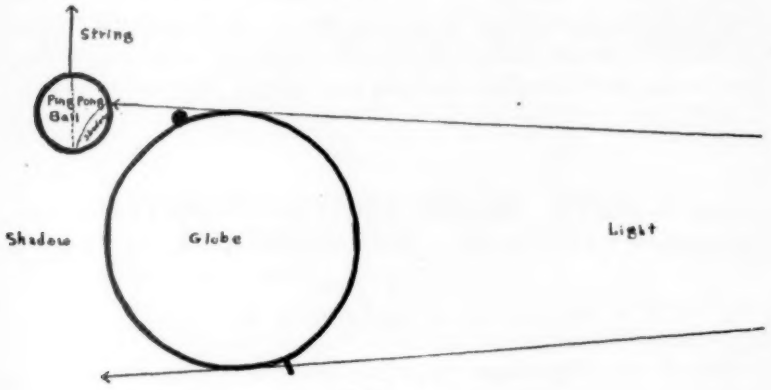

FIG. 2

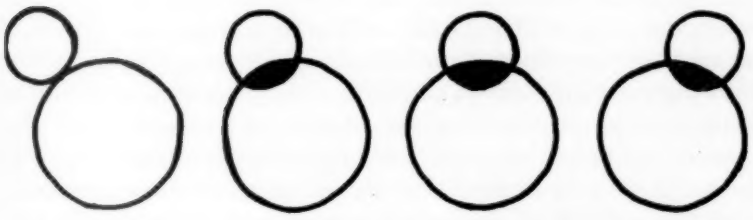

FIG. 3

FIG. 4

the moon and then gradually recede. To secure the effect of a partial eclipse move the ball into the shadow so that the top part remains in the illuminated area. (See Fig. 3.) For a total eclipse move the ball at a lower level so that it will move entirely into the shadow. (See Fig. 4.)

In presenting this demonstration to a group it must be remembered that the station of the observer is very important and that a good view can be obtained only from the region facing the lighted area of the globe and near the equipment. Only five or six persons can really see such a demonstration at one time. Demonstrations such as these may be varied to include timing the shadows on an earth scale, producing them in actual proportion to the earth's surface and photographing the various stages.

A NOTE ON THE USE OF DIRECTED LINES IN TRIGONOMETRY

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One of the first formulas a student encounters in analytic geometry is that for the slope of the line joining two points, (x_1,y_1) and (x_2,y_2). It is not at all unusual to discover students who see no difference in the two statements: $\tan \alpha = QP_2/P_1Q$ and $\tan \alpha = P_2Q/P_1Q$ and hence at one time obtain $m = (y_2-y_1)/(x_2-x_1)$ and another time obtain $m = (y_1-y_2)/(x_2-x_1)$. Or, knowing what the formula should be, if by chance the numerator of the fraction representing the tangent of α is written P_2Q by another compensating error it will be stated that this is equal to y_2-y_1. It may be argued that this is because of unfamiliarity with the concept of directed line segments. Nevertheless this concept is one which has been or could be introduced in trigonometry, and perhaps should have been emphasized.

Whether the text in trigonometry takes up the acute or the general angle first, sooner or later definitions are introduced which involve the use of abscissa, ordinate, and radius vector, at least two of which are definitely directed lines. To emphasize this point, let us consider an angle in standard position, that is with vertex O at the origin of a rectangular Cartesian coordinate system, the initial line the positive X-axis, terminal line OP, with PM the perpendicular from P upon the X-axis. Then the sine of the angle is MP/OP and not PM/OP, nor is it MP/PO; likewise the tangent is MP/OM, not PM/OM. Approximately thirty-five elementary trigonometry texts, published within the last dozen years, were examined as to their treatment of this topic. In defining the functions of the general angle only four

books made use of the endpoints of the line segments involved in the ratios. That is, the definition is

$$\sin \gamma = \frac{\text{ordinate}}{\text{radius vector}} = \frac{y}{r}$$

except in the four cases mentioned, where a supplementary statement equivalent to

$$\sin \gamma = \frac{\text{ordinate}}{\text{radius vector}} = \frac{y}{r} = \frac{QP}{OP}$$

was made. Granted that the ordinate and abscissa are directed lines, might not this additional step emphasize this concept, and in particular emphasize the *direction?*

Where a text gives a treatment of the line values of the functions the concept of directed line segments is universally employed, utilizing the initial and end point notation. If this notation is of value here, why should not it be mentioned elsewhere?

When dealing with the acute angle it might be claimed that since we are concerned with the ratio of undirected distances the matter is immaterial. The difficulty mentioned at the beginning of this note arises even if the angle α is acute. There certainly would be no harm is utilizing the directed segment even for acute angles; one could arbitrarily state a rule for acute angles: adjacent side is to be read from the vertex of the angle to vertex of right angle, hypotenuse from vertex of acute angle concerned, opposite side from vertex of the right angle. Some might propose a better wording, the important point is that this would be consistent with the abscissa, ordinate, and radius vector definition with the angle in standard position. As a matter of fact, not one of over thirty texts examined used the notation AB in referring to the side of a triangle when introducing the definitions of the functions of an acute angle. Invariably letters such as a, b, c or the words, opposite side, adjacent side, hypotenuse were employed. This in no case is to be construed as an argument for or against introducing the acute angle before or after the general angle; it merely raises the question as to whether the concept of direction may not be of value even in the case of the acute angle.

If this concept of direction be emphasized, a rather awkward situation can be avoided. Let us reproduce in brief a proof for the cosine of the sum of two angles. The derivation varies con-

siderably from text to text, just as there are several ways in which an inconsistency in sign appears. The proof, following Figure 1, is similar to that used in many texts:

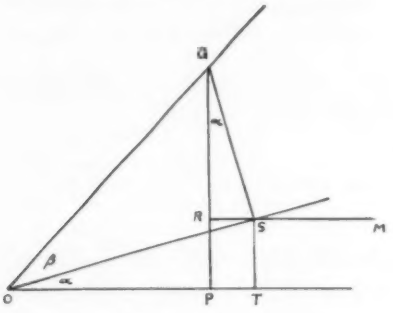


FIG. 1.

$$\cos(\alpha+\beta) = OP/OQ = OT/OQ - PT/OQ$$
$$= (OT/OS)(OS/OQ) - (RS/QS)(QS/OQ)$$
$$= \cos\alpha\cos\beta - \sin\alpha\sin\beta.$$

Now if directed lines have any meaning, QS/OQ is not $\sin\beta$ but rather $-\sin\beta$. Some texts point out that the proof holds only if α and β are acute, others are not clear on this point. In extending to the general situation at least two texts make statements which are to say the least questionable. A rather common statement is to the effect that if the concept of directed lines is employed the figure and proof will hold with no restriction as to the size of the angles. In some instances the proof would certainly need modification; in general this statement is like many others of the type: "it obviously follows," or, "it is readily seen that. . . ." Many students will have difficulty; bright students may raise embarrassing questions about the text proof.

In a proof of this nature, if we need directed lines for the general case, and no serious difficulty appears in their use in a special case, why not employ them there? The difficulty can be avoided, for example, if a slight variation in the proof is introduced, namely that the angle MSQ is $\frac{1}{2}\pi+\alpha$, there is no trouble about directed lines; the proof is essentially as simple, and extensible to any situation. To state the argument another way, since we need to utilize the concept of directed lines except in a very special situation, why run the risk of confusing the student now or later with a seeming inconsistency or a failure to make clear an important concept?

PER PUPIL COSTS IN SCIENCE

RALPH E. KEIRSTEAD
Rogers High School, Newport, Rhode Island
JOSEPH H. ROHLOFF
Aldrich High School, Warwick, Rhode Island
EDWARD P. SAWIN
Cranston High School, Cranston, Rhode Island

While it is conceded generally that science courses in the senior high school are expensive, it is not easy to obtain exact information as to *how* expensive such courses are. No standards are available to science teachers in planning expenditures nor to school administrators in evaluating requests for expenditures for scientific purposes. In many school systems, severe competition develops between various departments of the school for the money appropriated for supplies and equipment. Thus, many school systems have no systematic basis for expenditure of funds for science, or, for that matter, for other fields.

The present study was undertaken to gather data concerning the costs per pupil of various senior high school sciences. It was recognized at the outset that such data could not be considered as standards which could be followed rigidly. Rather, such data would be indicative of present practices, and evaluation of which should point to the desirability of further investigations. The study was limited purposely to instructional materials. No attempt was made to investigate salaries of science teachers or capital expenditures for science classrooms and laboratories.

The first task was a study of educational literature to learn what had been done by other investigators with this problem. Rather careful search failed to reveal any published study concerning per pupil costs of instructional materials. Extensive correspondence with leaders in science education confirmed this finding. Thus, so far as is known to the authors, no study has ever been made of this particular phase of science education. It was heartening, indeed, however, to receive expressions of approval of the project from a considerable number of educational leaders.

Since no published data were available, it was necessary to go directly to original sources—i.e. the financial records of various cities and towns. To facilitate tabulation of data a form was devised which included seven categories of instructional materials. These categories were named and defined as follows:

Textbooks—Bound volumes used for regular class and laboratory work.

Supplies—Materials used *only once*, such as chemicals, filter paper, and biological specimens for dissection.

Equipment—Apparatus used *more than once*, such as electrical meters, glassware, ringstands and barometers.

Printed Matter—Consumable materials such as workbooks and tests.

Reference Books and Magazines—Library materials deposited in science rooms and not within the control of the general school library.

Visual Materials—Projectors and projection materials, whether rented or purchased.

Maintenance—General supplies such as paint, solder, steel wool and soap used in all subjects. Total cost to be divided equally among the different sciences.

It was recognized that many items of science equipment are used over a period of years and that strict adherence to commercial practice would require distribution of costs over a number of years. To do this, however, would require an exceedingly complicated system of depreciation scales. Consequently, it was felt more desirable to charge the total cost on the year of purchase. It was felt that no serious error would be introduced provided the costs of equipment for a new science plant were not included. Since the study is not concerned with an analysis of original costs in equipping a new building, it was felt that the purchase of new books and equipment would average out over a period of three or four years.

Through the friendly cooperation of a number of school administrators and science teachers more or less complete data were obtained from ten schools. These data are tabulated in four tables. In almost all cases, the figures listed are somewhat lower than the actual cost due to difficulties in obtaining complete records of all expenditures.

Table I compares the data obtained from the ten schools by years under four main headings:

1. Average annual per pupil cost for all sciences. This figure was obtained by dividing the total expenditures for Physics, Chemistry and Biology by the total enrollment in these subjects.

2, 3, 4. Annual cost per pupil for Physics, Chemistry and

TABLE I

COSTS PER PUPIL PER YEAR OF INSTRUCTIONAL MATERIALS IN SCIENCE

School	Average All Sciences				Physics			
	'37–'38	'38–'39	'39–'40	'40–'41	'37–'38	'38–'39	'39–'40	'40–'41
A (1)		$2.40	$ .83	$ 2.00				
B (1)		1.57	1.03	1.50				
C (1, 2)				12.45				
D (1)			.78	.78			$4.50	$3.17
E	$1.57	.80	1.06	1.51	$ 3.16	$2.28	$1.60	$1.31
F (1)	1.11	1.70	1.20	1.17	.79	.68	.60	1.25
G (3)				6.63				
H (4)				1.00				
I	1.00	1.17	1.25	.92	1.87	1.97	1.30	1.42
J (1, 2)			7.43	2.43			1.63	2.36

School	Chemistry				Biology			
	'37–'38	'38–'39	'39–'40	'40–'41	'37–'38	'38–'39	'39–'40	'40–'41
A (1)								
B (1)								
C (1, 2)								
D (1)			$ .65	$ 1.02			$ .11	$ .14
E	$ .99	$ .65	1.53	2.60	$1.56	$ .66	.48	.72
F (1)	3.30	3.52	2.92	1.88	.08	1.72	.75	.43
G (3)								
H (4)								
I	1.38	2.08	1.32	.78	.50	.27	1.18	.91
J (1, 2)			13.94	3.75			6.96	1.92

(1) General science classes draw upon other sciences for supplies and equipment.
(2) Includes some costs of original equipment for new school.
(3) Private school which offers some advanced work in addition to usual secondary school sciences.
(4) School does not furnish textbooks.

Biology, respectively. These figures are obtained by dividing the total expenditure for the subject by the total enrollment in that subject.

This table is interesting in several respects.

1. It indicates a very wide variation in average per pupil cost.
2. It indicates that Biology is, on the average, less expensive than the other sciences.
3. There seems to be wide variation in costs from year to year in the same science in a particular school.

A very large "Why" comes to mind after each statement. The scope of the study did not include an attempt to answer

that question. However, it would seem to be worthy of serious attention in the future.

Tables II, III, and IV are tabulations of per pupil costs per year in Physics, Chemistry and Biology respectively for each of the various categories used on the tabulation sheet. Only four schools are included in this tabulation. They are the schools from which most accurate and most complete data were obtained. Again several interesting things show up:

1. The costs of Physics instruction seems to bear some direct relationship to the number enrolled in that subject.
2. The costs of Chemistry and Biology do not seem to be so closely related to the number of pupils enrolled.
3. Textbooks seem to make up a large proportion of the costs of instructional materials, expecially in biology. This item varies greatly from school to school.
4. Reference books, magazines and motion pictures or other projection materials seem to contribute almost negligibly to the costs of instruction.

TABLE II

COSTS PER PUPIL PER YEAR IN PHYSICS BY CATEGORIES

Year	Texts	Equipment	Supplies	Printed matter	Reference books, magazines	Motion picture slides	No. pupils	Total
School E								
1937–38				$.14		$3.02	15	$3.16
1938–39	$1.50			.78			10	2.28
1939–40	1.60						22	1.60
1940–41		$1.31					24	1.31
School F								
1937–38		.65	$.02		$.02	.10	254	.79
1938–39		.62	.05		.02		238	.68
1939–40	.03	.55	.01		.01		263	.60
1940–41	1.13	.09	.01		.02		253	1.25
School I								
1937–38	.36	1.47			.05		113	1.87
1938–39	.55	1.42					131	1.97
1939–40	.15	1.15					115	1.30
1940–41	.14	1.21	.06		.02		106	1.43
School J								
1939–40	.30	.33	.17	.17		.67	30	1.63
1940–41	.36	.60	.20			1.20	25	2.36

The reasons back of the variation offer challenges to further investigation. While these tables raise more questions than they answer, they do afford some idea of the range of expenditures. They probably show clearly that the laboratory aspect of science receives widely varying attention.

In gathering data for this study a number of exceedingly interesting facts come to light. In the greater number of school systems, the financial records are kept in such a form that it is a very great task to sort out expenditures for any particular subject or category. Enrollment statistics are kept in rather incomplete form in most schools. Very few schools have any well organized system for keeping a permanent inventory of books, supplies, and equipment.

Because of these findings the authors spent considerable time in devising a variety of record forms for use by administrators and science teachers in setting up a more orderly and useful accounting system both for expenditures and for inventory

TABLE III

COSTS PER PUPIL PER YEAR IN CHEMISTRY BY CATEGORIES

Year	Text	Equipment	Supplies	Printed matter	Reference books, magazines	Motion picture slides	No. pupils	Total
School E								
1937–38		$ .66	$ .26	$.06			40	$ .98
1938–39		.54	.11				34	.65
1939–40	$.23	.22	.33	.75			47	1.53
1940–41	.72	.86	.29	.72			44	2.60
School F								
1937–38	.79	1.27	.61	.44	$.05	$.23	103	3.39
1938–39	.88	1.27	.50	.85	.03		130	3.52
1939–40	.17	1.42	.85	.50			125	2.92
1940–41		.46	.66	.60	.16		118	1.88
School I								
1937–38	.04	.55	.18		.01		310	.78
1938–39	.18	.58	.56				309	1.32
1939–40	.65	.65	.78				312	2.08
1940–41	.27	.50	.61				329	1.38
School J*								
1939–40	.30	4.07	8.05	.72		.80	25	13.94
1940–41	.17	2.25	1.00			.33	60	3.75

* New school, some original equipment included in costs.

TABLE IV

COSTS PER PUPIL PER YEAR IN BIOLOGY BY CATEGORIES

Year	Texts	Equipment	Supplies	Printed matter	Reference books, magazines	Motion picture slides	No. pupils	Total
School E								
1937–38	$ .80			$.06		$.70	65	$1.56
1938–39		$ .66					70	.66
1939–40				.48			59	.48
1940–41	.60			.72			65	.72
School F								
1937–38	.25	.14	$.06		$.03		146	.43
1938–39		.31		.06		.38	145	.75
1939–40	1.66		$.06				127	1.72
1940–41	.06	.02					141	.08
School I								
1937–38	.19	.22	.08		.01		430	.50
1938–39	.03	.11	.13				433	.27
1939–40	.67	.30	.21				383	1.18
1940–41	.63	.13	.09			.06	434	.91
School J								
1939–40	.30	5.66	.40	.20		.40	50	6.96
1940–41	.30	.82	.33			.47	150	1.92

* New school, costs include some original equipment.
The categories listed are the same as used on the tabulation form.
The schools are listed by letter as in Table I.

purposes. Copies of this form may be obtained from anyone of the authors by those interested.*

The authors feel that the most significant result of the study is the indicated need for the accumulation of more data. Consequently, the study will be continued. If readers of this article should wish to assist in accumulating data, their assistance will be welcomed. Any one of the authors will be pleased to receive correspondence concerning the matter.

* A few copies are available of the complete report and will be mailed to those interested on receipt of ten cents to cover mailing costs.

When you change address be sure to notify Business Manager W. F. Roecker, 3319 N. 14th Street, Milwaukee, Wis.

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON
State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the ones submitted in the best form will be used.

LATE SOLUTIONS

1733. *Mrs. Walter Edith Warne, Rochester, N. Y.; Walter R. Warne, Rochester, N. Y.: Bessie Lucas, Earlville, N. Y.*

1747. *Proposed by Daniel Kenney, Hoyt's Corners, N. Y.*

Find the sum of the fourth powers of the roots of

$$x^3-2x^2+x-1=0.$$

Editor's Note: Since this problem was earlier proposed and two solutions were offered in November 1941 issue, no solution will be offered now.

Solutions were offered by Paul C. Overstreet, Wilmore, Ky.; Walter R. Warne, Rochester, N. Y.; Daniel Kinney, Hoyt's Corners, N. Y.; and Norman Anning, University of Michigan.

1748. *Proposed by Blanche McGuire, Junius, N. Y.*

If a, b, c are the roots of

$$x^3+2x^2-3x-1=0 \tag{10}$$

find $a^{-3}+b^{-3}+c^{-3}$.

First solution by Paul C. Overstreet, Wilmare, Ky.

Transform (10) by letting $x=1/y$, this gives

$$y^3+3y^2-2y-1=0. \tag{20}$$

Let p, q, r be the roots of (20)
Then,

$$a^{-3}+b^{-3}+c^{-3}=p^3+q^3+r^3.$$

From 20, we have

$$\sum p=-3; \quad \sum pq=-2; \quad pqr=1$$

$$(\sum p)^3=-27=\sum p^3+3\sum p\cdot\sum pq-3pqr=\sum p^3+3(-3)(-2)-3.$$

Hence,

$$\sum p^3=p^3+q^3+r^3=a^{-3}+b^{-3}+c^{-3}=-42.$$

Second solution by Norman Anning, University of Michigan.

Let

$$z=x^3.$$

Then

$$\begin{aligned}(1-z)^3&=(2x^2-3x)^3\\&=8x^6-27x^3-18x^3(2x^2-3x)\\&=8z^2-27z-18z(1-z).\\z^3+23z^2-42z-1&=0.\end{aligned}$$

The sum of the reciprocals of the roots of this equation is, by inspection, -42.

Solutions were also offered by W. R. Warne, Rochester, N. Y.; Paul D. Thomas, Durant, Okla.; and Scobey Warne, Union Hill, N. J.

1749. *Proposed by Walter R. Warne, Rochester, N. Y.*

An equilateral triangle with area 10,000 is surrounded by a walk of uniform width and equal to the area of the inscribed circle. What is the width of the walk?

Solution by Helen M. Scott, Baltimore, Md.

Let a be a side of the triangle, A the area, r the radius of the inscribed circle and x the width of the walk.

$$A=10{,}000$$

$$A=\frac{a^2}{2}\sin 60=\frac{a^2}{4}\sqrt{3}$$

$$r^2=\frac{a^2}{12}$$

$$r=\sqrt{\frac{A\sqrt{3}}{9}}=\frac{100}{3}\sqrt{\sqrt{3}}.$$

Area of walk: $3x^2\sqrt{3}+3ax=\pi r^2$

$$x^2+\frac{ax}{\sqrt{3}}=\frac{\pi r^2}{3\sqrt{3}}$$

$$x^2+2rx=\frac{\pi r^2}{3\sqrt{3}}$$

$$x=r\left[\sqrt{\frac{\pi+3\sqrt{3}}{3\quad 3}}-1\right]=11.7.$$

Solutions were also offered by Charles P. Louthan, Columbus, Ohio; W. R. Smith, Suttons Bay, Mich; Henry Barbour, Glen Ellyn, Ill.; and the proposer.

1750. *Proposed by Howard Hoagland, Toronto, Canada.*

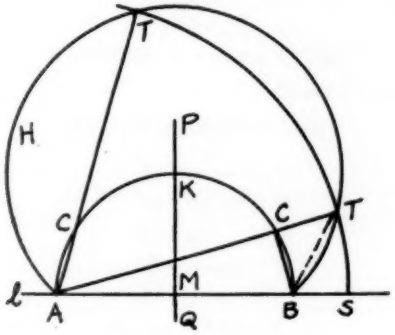
In a right triangle, if the hypotenuse and the sum of the other two sides are given, give a Euclidean construction to determine the three sides.

Solution by Adrian Struyk, Paterson, N. J.

If "Euclidean construction" means that the compass may not be used to transfer distances, we may proceed as follows:

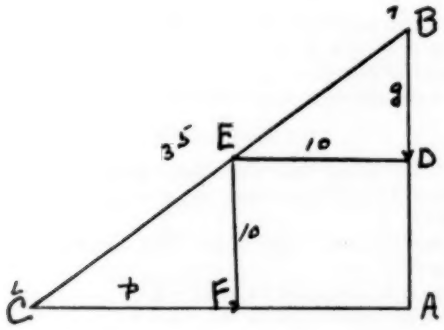
By means of Euclid I, determine, on a line l, points A, B, S such that AB is the given hypotenuse, AS, the given sum of the legs. Construct the perpendicular bisector PQ of AB. The midpoint M of AB is thus obtained. Draw the circle with center M, radius MA, and let it cross PQ at K. Draw the circle with center K, radius KA, and intersect it at T by the circle with center A, radius AS. Draw AT, intersecting circle AKB at C.

Then AC and CT are the sides required, and $\triangle ABC$ is the required triangle.



Proof: The semicircle AKB makes $\triangle ABC$ a right triangle. The hypotenuse AB has the given length, by construction. In circle AHB, the central $\angle AKB$ is a right angle. Hence the inscribed $\angle ATB = 45°$. This, with $\angle BCT = 90°$ makes $\angle CBT = 45°$. Then $\angle ATB = \angle CBT$ in $\triangle CBT$ makes $BC = CT$. Hence, $AC + CB = AC + CT = AT$. By construction, $AT = AS$ = given sum of the legs.

Solutions were also offered by Walter R. Warne, Rochester, N. Y.; Rebecca Johnson, Primes Coove, N. Y.; Eva Baxter, Liverpool, N. Y.; Susie Thomas, Carbondale, Pa.; Lucille Rich, Albany, N. Y.; D. F. Wallace.



1751. *Proposed by Roy H. Luce, Chinchilla, Pa.*

The hypotenuse BC of a right triangle ABC is 35. A square $ADEF$, with each side 10, is placed so that E is on BC and AD and AF lie on AB and AC respectively. Find the length of AB.

Solution by Paul C. Overstreet, Wilmore, Ky.

In the figure,

$$p/10=10/g \quad \text{or} \quad pg=100.$$

Also,

$$(p+10)^2+(g+10)^2=35^2=1225,$$

or,

$$p^2+g^2+20(p+g)+200=1225$$

or, since

$$2pg=200,$$

$$(p+g)^2+20(p+g)-1225=0.$$

Using the quadratic formula

$$p+g=-10+5(53)^{1/2}=26.40.$$

Hence,

$$p^2+2pg+g^2=697$$

$$4pg=400$$

$$p^2-2pg+g^2=297$$

$$p-g=17.23$$

$$p=21.82; \quad g=4.58$$

$$AC=p+10=31.8; \quad AB=g+10=14.6.$$

Solutions were also offered by D. F. Wallace, Minn.; W. R. Smith, Suttons Bay, Mich.; Helen M. Scott, Baltimore, Md.; Dennis Wallenback, Montour Falls, N. Y., and the proposer.

1752. *Proposed by Dannis Wallenback, Montour Falls, N. Y.*

The sum of two roots of the equation $x^4-8x^3+21x^2-20x+5=0$ is 4. Explain why, on attempting to solve this equation by use of this fact, that the method fails.

Solution by Adrian Struyk, Paterson, N. J.

Since the sum of two roots is 4, and the sum of all four roots is 8, we may denote the roots by r, $4-r$, s, $4-s$.

Then the product of the roots gives $rs(4-r)(4-s)=5$.

And the two root-coefficient relation leads to

$$4r+4s-r^2-s^2=5.$$

Elimination of s from these two equations gives the equation $f(r)=0$, where $f(x)=0$ denotes the given equation. The preceding statement is the explanation sought.

Although the above "usual" procedure fails, the equation can be solved by using the fact given.

Let the roots be a, b, c, d; and let $a+b=4$.

Then, since $a+b+c+d=8$, we have $c+d=4$.

From the product of the roots:

$$abcd=5. \tag{1}$$

The sum of the products of three roots gives

$$abc+abd+acd+bcd=20.$$

This may be written $ab(c+d)+(a+b)cd=20$, and hence reduces to

$$ab+cd=5. \tag{2}$$

From equations (1) and (2) we find the values of the products ab and cd. Thus,

$$ab=\tfrac{1}{2}(5+\sqrt{5}), \quad cd=\tfrac{1}{2}(5-\sqrt{5}).$$

These, with the equations $a+b=c+d=4$, lead to the roots, which are

$$\tfrac{1}{2}(3+\sqrt{5}), \quad \tfrac{1}{2}(3-\sqrt{5}), \quad \tfrac{1}{2}(5+\sqrt{5}), \quad \tfrac{1}{2}(5-\sqrt{5}).$$

Editor's Note: This problem appears in Hall and Knight's *Higher Algebra*, page 489.

Solutions were also offered by William Critchin, Murray, Ky. and Norman Anning, Michigan.

STUDENT HONOR ROLL

This editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted to this department. Teachers are urged to report to the Editor such solutions.

No solutions were offered for this issue.

1749. *Henry Barbour, Glen Ellyn, Ill.*

SOLUTIONS FOR TWO UNSOLVED PROBLEMS

1738. *Proposed by Nellie E. Walters, Canoga, N. Y.*

If a, b, c are sides of a triangle show that

$$\left(1+\frac{b-c}{a}\right)^a\left(1+\frac{c-a}{b}\right)^b\left(1+\frac{a-b}{c}\right)^c<1.$$

Solution by Malcolm Kirk, West Chester, Pa.

Suppose

$$c>a>b. \tag{1}$$

Then

$$a(c-b)>b(c-b). \tag{2}$$

Multiplying

$$b=b \tag{3}$$

$$b^2+abc>b^2c+ab^2 \tag{4}$$

$$(c-a)^2=(c-a)^2 \tag{5}$$

$$a>b. \tag{6}$$

Multiplying

$$a^3+2abc>a^2b+c^2b+2a^2c-ac^2 \tag{7}$$

$$a^2+c^2>2ac \tag{8}$$

$$c=c. \tag{9}$$

Multiplying

$$c^3>-a^2c+2ac^2. \tag{10}$$

Adding (4), (7), and (10),

$$a^3+b^3+c^3+3abc>b^2c+ab^2+a^2b+c^2b+a^2c+ac^2. \tag{11}$$

By factoring

$$\left(1+\frac{b-c}{a}\right)\cdot\left(1+\frac{c-a}{b}\right)\cdot\left(1+\frac{a-b}{c}\right)<1 \tag{12}$$

or

$$\left(1+\frac{b-c}{a}\right)^a\cdot\left(1+\frac{c-a}{b}\right)^b\cdot\left(1+\frac{a-c}{c}\right)^c<1.$$

Since $c>a>b$.

If the three sides are unequal, whatever the relations between the sides, the pattern of demonstration here adopted will yield the proposed inequality.

If any two sides are equal the proposed inequality persists by virtue of the inequality—the sum of the squares of any two quantities is greater than twice the product.

If, however, $a=b=c$ the left hand member of the proposed inequality $=1$, the only exception taken to the problem.

A solution was also offered by Adrian Struyk, Paterson, N. J.

1684. *Proposed by Walter R. Warne, Rochester, N. Y.*

If a and b are positive integers, show that

$$\frac{(2a)!(2b)!}{a!b!(a+b)!}$$

is an integer.

Solution by A. J. Zanolar, Collegeville, Ind.

Any prime may be shown to appear in the numerator to at least as high a power as in the denominator. The power to which any prime, p, appears in $N!$ is given by

$$\sum [N/p^i]=[N/p]+[N/p^2]+\cdots+[N/p^i], \quad (p^i\geqq N),$$

where $N/p^i=n_i+h_i/p^i$, and $[N/p^i]=n_i$ (n_i an integer and $h_i<p^i$).

Hence it is desired to prove

$$\sum [(2a)/p^i]+\sum [(2b)/p^i]\geqq\sum [a/p^i]+\sum [b/p^i]+\sum [(a+b)/p^i], \tag{I}$$

in which, on the assumption that $a\geqq b$, $p^i\geqq 2a$.

Let

$$a/p=k_1+q_1/p,\ a/p^2=k_2+q_2/p^2,\cdots,\ a/p^i=k_i+q_i/p^i \quad (q_i<p^i)$$

$$[a/p]=k_1,\ [a/p^2]=k_2,\cdots,\ [a/p^i]=k_i$$

$$\sum [a/p^i]=\sum k_i. \tag{1}$$

Then

$$(2a)/p=2k_i+(2q_i)/p^i,\quad [(2a)/p^i]=2k_i+[(2q_i)/p^i],$$

and

$$\sum [(2a)/p^i]=2\sum k_i+\sum [(2q_i)/p^i]. \tag{2}$$

(The term $\sum[(2q_i)/p^i]$ must be included since $2q_i$ may be greater than p^i for some values of i.) Similarly, if

$$b/p^i=m_i+r_i/p^i, \quad (r_i<p^i), \quad [b/p^i]=m_i,$$

$$\sum [b/p^i]=\sum m_i \tag{3}$$

$$\sum [(2b)/p^i]=2\sum m_i+\sum [(2r_i)/p^i]. \tag{4}$$

Also

$$\sum [(a+b)/p^i]=\sum k_i+\sum m_i+\sum[(q_i+r_i)/p^i]. \tag{5}$$

From the expressions, (1), (2), (3), (4), (5), we obtain the relation (1) after using the values which follow

$$\sum [(2q_i)/p^i]+\sum [(2r_i)/p^i]\geqq\sum [(q_i+r_i)/p^i]$$

which is easily proved to be true for any prime p and for values of q_i and r_i as defined above. Since p is any prime whatsoever, it follows that the given expression is an integer.

EDITOR'S NOTE: A solution to this problem by G. E. Wahlin, University of Missouri, appeared in the *American Mathematical Monthly*, 1911, pp. 41–43. The problem is mentioned in Dickson's *History of the Theory of Numbers*, V. I, pp. 265.

PROBLEMS FOR SOLUTION

1765. *Proposed by J. Seward Bodine, Salt Lake City, Utah.*

If $z^n=x^n+y^n$, show $z^m >$ or $<(x^m+y^m)$ according as $m>$or$<n$.

1766. *Proposed by Isabella Moore, Boston, Mass.*

In a given circle draw a chord of fixed length which shall be bisected by a given chord.

1767. *Proposed by Elizabeth Vreeland, Baileytown, N. Y.*

Divide a given triangle into two equivalent parts by a line perpendicular to one of the sides.

1768. *Proposed by Florence Dean, Cayuga, N. Y.*

If

$$\frac{x}{a^2-y^2}=\frac{y}{a^2-x^2}=\frac{1}{b}$$

and if $xy=c^2$, show that when a and c are unequal $a^2+c^2-b^2=0$.

1769. *Proposed by Nathan Yoder, Richmond, Va.*

If $a+b+c=bc-ca-ab$ and if a, b, c are real, show that the product, bc, is negative.

1770. *Proposed by Grace Brown, Washington, D. C.*

Solve for x:

$$\sqrt{\frac{x+a}{x}}+2\sqrt{\frac{a}{x+a}}=b^2\sqrt{\frac{x}{x+a}}.$$

Colleges are places where pebbles are polished and diamonds are dimmed. —R. G. INGERSOLL.

SCIENCE QUESTIONS

April, 1942

Conducted by Franklin T. Jones,
10109 Wilbur Avenue, SE, Cleveland, Ohio

Contributions are desired from teachers, pupils, classes and general readers. Send examination papers from any source whatsoever, questions on any part of the field of science, tests, questions having to do with the pedagogy of science—in fact, anything that appeals to the reader or might appeal to other readers; also, anything that will help to make the subjects arrayed under SCIENCE more useful or more interesting to teachers and pupils. Select your own topic. It will, most likely be interesting to others.

We will endeavor to get answers to all reasonable questions. It is always valuable to get questions whether they can be answered or not.

Contributors to SCIENCE QUESTIONS are accepted into the GQRA (Guild of Questions Raisers and Answers).

Classes and teachers are invited to join with others in this co-operative venture in science.

HOW TO KEEP UP WITH SCIENCE AND INDUSTRY?
Is our monthly question for 1942.

REQUESTS BY READERS

(Under this heading will be carried the names of those who wish to be put in the way of "Keeping Up with Industry.")

950. *Requests on "How to Keep Up With Science and Industry in 1942."*
Previously reported—
Joseph W. Brewer, Eskridge Rural High School, Kansas.
Fannie Hopkins, 14 West Ave., N., Milwaukee, Wis.
Science Instructor Kassay, Newtown, Pa.
New Requests—
J. C. Stumpf, 367 Mavis Drive, Los Angeles, Calif.
Rev. Brother P. V. Shea, St. Bonaventure's College, St. John's, Newfoundland.
Additional Trade (and other) Publications—

10. Pick Industries, Inc., Honey Bee Observatory, West Bend, Wisconsin.
11. "Here Today—Gone Tomorrow," Travelers Insurance Co., (1941 Accident book) Hartford, Conn.
12. "Fire Protection in Civilian Defense," U. S. Office of Civilian Defense, Washington, D. C.
13. "The Automobile User's Guide—With Wartime Suggestions, on How To Get The Most Out of Your Car")Customer Research Staff, General Motors, Detroit, Mich.
14. "Safeguarding Against Air Raids"—Savings & Loan News, February, 1942.
15. Training Films—Office of Civilian Defense, Washington, D. C. In Preparation—12 Films on "How to Act in an Air Raid." First film probably now available through your Local Defense Council—If they have not purchased film, get your own School Board to purchase.
16. Safety Research Institute, 420 Lexington Avenue, New York.
17. "Blaze Beaters Go to College"—*This Week* Magazine (with your Sunday paper for February 15, 1942).

"Defense volunteers, learning to fight fires, are finding that there's a lot more to it than just squirting a hose."

"Training programs include such subjects as the chemistry of fire, the behaviour of the human mind under fire conditions, tactics, arson and sabotage, hydraulics, rescue equipment and special tools, gas, vapor and dust explosions, evacuation of buildings, spontaneous ignition and industrial chemical hazards.

"Do the boys want such stuff? The best answer is the 15,000 increase in attendance over 1940's enrollment."

THREE MILES A MINUTE—DOWN

938. *Suggested by a picture in the Artgravure Section of* The Cleveland Plain Dealer *of October 5, 1941.*

Arthur H. Starnes, veteran pilot and parachute jumper, is scheduled to serve as a human guinea-pig for one of the most scientifically planned jumps in the history of aviation. Starnes will jump from 35,000 feet, the sub-stratospheric altitude at which the latest type of combat planes perform. He plans to plummet earthward for 33,000 feet before opening his parachutes. His weight is 193 pounds and his equipment weighs 113 pounds.

This jump took place on October 24, 1941, and was written up in the public press of that date (about). In *Life* of November 10, 1941, pp. 44–45. The results and description can be found. Also, in *The Reader's Digest*, January, 1942, pages 77–78.

He stepped out of the plane into 46 degree-below-zero cold at 31,400 feet. In the next 116 seconds he took a "free fall" to 1,500 feet above the ground, when he pulled the ripcord of his smaller parachute. The jerk of the quick slackening jolted him into momentary black-out.

At the end of the first quarter-mile of free fall, he attained his highest velocity, traveled down the rest of his nearly six-mile parabola to earth at an average speed of 170 M.P.H.

His equipment was a parachute on his back, another larger one on his chest, oxygen mask and supply, cover-all suit electrically heated, headphones on his chamois helmet, a tiny radio transmitter strapped around his waist recorded his heart beats, a cardiograph to register heart action, a pneumograph to record breathing, a barograph to record air-pressure changes, and an automatic motion picture camera on his right hip, pointed downward.

The total time of fall was four-and-a-quarter minutes.

If he had not opened his chute at 1,500 feet he would have struck the earth in six more seconds. His only injury resulted from biting his lip when his first parachute opened.

This fall was rehearsed several times in the Northwestern University high-altitude chamber.

Many interesting problems in falling bodies can be made up from the above account of Starnes "free-fall."

THE COW JUMPED OVER THE MOON

952. *From "Brain Teasers," edited by F. Benington, in the Double Bond of the Western New York Section of the American Chemical Society.*

Find how much work was done when the cow jumped over the moon.

(Her weight in pasture was 900 lb.; but, as she went up, her weight varied inversely as the square of her distance from the center of the earth, and this distance varied from 4,000 miles in the pasture to 240,000 miles at the moon.)

Answer. 1,770 mile-tons.

CONSERVATION

956. *Under this title and number there will be published from time to time some phases of "conservation" not usually dealt with by the Conservation Service or Committees on Conservation.*

(1) Conserving rubber in the home—

Carlessness and conservation are conflicting terms. The great enemies to the long life of rubber goods are: heat, sunlight, oil, grease, and gasoline. Exposure to any of these destroyers is anti-conservation. Avoid having rubber surfaces come together when wet, therefore, conservation says to dry rubber surfaces or keep them from coming together.

Keep your rubbers away from a radiator, hot register or from in front of a hot fire. When rubber boots get wet inside, take any long stick of wood or dry pole and stand in the boot so that the foot and leg can dry out. For knee-length boots, the stick is not necessary; but stuff wadded up newspaper into the boot for a little while and you will be surprised how much moisture the paper will take up.

Rubber raincoats: Do not let one part of the coat lie against another while drying out. Use a coat hanger and hang where air can circulate around the coat.

Hot-water bottles. Stand them up on a small stick until all the water has drained out. Then hang them up with the walls surely not against one another. Leave with some air inside. Hang them up.

Rubber gloves: After they have been dried off on the outside, put in some talcum powder and stand up on a stick that will go to the end of the glove finger. Give the inside a circulation of air.

Gardenhose: Empty out all the water and hang up loosely on a couple of wooden pegs spaced about six inches apart.

Rubber tape: Keep it away from heat.

(2) Woods: Many woods have been cut-over in the past twenty years. Clean up the rubbish, pile the brush, leave room for the little trees to get a fresh start. If a maple now and then is left standing, it will re-seed a considerable area quickly. Such little trees grow very fast. If you have a fruiting hickory, let one stand. Many of the nuts will sprout and grow quite rapidly into trees. Rabbits like the young shoots so you may have to put some wire around a tree now and then to make sure that some survive. Rabbits go for butternut shoots too.

(3) Worn Machine Parts: Some worn parts can be built up with an electric-welder, or torch, or molten metal can be sprayed on surfaces and then machined off again to size and shape. Be cautious about this treatment where special metals are required or special heat treats.

(4) Molybdenum for Tungsten in some Cutting Steels: It has been found by research that molybdenum (produced in the U. S. A.) can be used in place of tungsten (From China and Burma).

(5) Eyes: Eye injuries occur at the rate of about 1,000 a day and

cause an annual loss of $200,000,000. (Report of National Society for Prevention of Blindness.) Take good care of your eyes.

(6) Conserve the lives of the boys and girls: In ten years there were over 3,765 young people killed and 6,890 injured while trespassing on railroad property. (Circular No. S-176, Association of American Railroads.) Keep the boys and girls off railroad property.

WHAT TO DO BEFORE THE BOMBERS COME

957. *After W. B. Courtney in* Collier's, *January 17, 1942.*

(1) Clean out your attic and cellar. Get rid of all accumulations of paper and rubbish and kindling wood.

(2) If you are going to be thorough, spray fireproofing on the floors and rafters of your attic and then spread a coat of 2 inches of sand on the floor. This has been found very effective in England. This can not be attended to too soon!!!

(3) Get ready for thorough blackout of your own house. You can now buy gadgets to make your curtains fit tight to the window frames. Better get an extra set of dark shades that can be made to fit tight.

(4) Brace your cellar rafters so that the house will not fall down on you in a raid. This is not joking either!!

(5) Equip some of your flashlights with blue glass. You can see a lot more than nothing with such a flashlight. An ordinary flashlight can be seen for a mile if not blued.

(6) Find out how and where to turn off the water and gas at the street so a burst will not asphyxiate or drown you if you do have to take refuge in your cellar.

(7) Have someone in the family take a Red Cross First Aid training course. Common sense is good but trained common sense is better.

(8) Rig up an electric fan in your cellar. It will help to keep the air clear of fumes.

(9) Learn how to handle incendiary bombs. A plane can carry 2,000 of the things and one might happen to go off on your premises. See the picture about "How to Fight an Incendiary Bomb Fire." Your local defense council should be showing it soon. See it every time you can. Get the tools suggested ready. Organize your own household for defense.

(10) Don't put it off. Learn as fast as you can. You do not know how soon you are going to be exposed to bombing.

(11) Read Courtney in full. *Collier*'s January 17, 1942. Pp. 14–15. He says in closing, "Remember that air-raid bombs, and anti-aircraft shells, are something like a bolt of lightning; if your number is on one, you can't outrun it."

SEND IN REFERENCES TO ARTICLES THAT PRESENT-DAY PROBLEMS DICTATE SHOULD BE READ BY TEACHERS AND PUPILS
JOIN THE GQRA!

It is better to know a few things and to have the right use of them than to know many things which you cannot use at all.—SENECA.

BOOK REVIEWS

TOOLS. A MATHEMATICAL SKETCH AND MODEL BOOK, by Robert C. Yates, *Associate Professor of Mathematics, Louisiana State University.* Loose-leaf Binder. 25×29 cm. 193 pages. Louisiana State University Press, Baton Rouge. 1941. Price $1.60.

This book is a decided departure from the standard course in college geometry. As the title implies, the book deals with the geometry which grows out of the use of various mathematics tools. It is in the form of a loose-leaf work-book and laboratory manual.

The material is divided into eleven sections with headings as follows: The Straightedge and Modern Compasses (Modern Geometry); Dissection of Plane Polygons; The Compasses (Geometry of Mascheroni); Folds and Creases (Geometry of Paper Folding); The Straightedge (Synthetic Projective Geometry; Line Motion Linkages (How to Draw a Straight Line); The Straightedge with Immovable Figure (Geometry of Poncelet-Steiner); The Assisted Straightedge; Parallel and Angle Rulers; Higher Tools and Quartic Systems; General Plane Linkages.

For a satisfactory handling of the material presented the student should be familiar with college algebra, trigonometry, and analytical geometry. Enough material is provided for a three hour course covering a period of one year. The author suggests that two hours per week be spent in the classroom and the third, in the laboratory. It is intended that the student be supplied with a supplementary notebook with ring binder for keeping notes and drawings for which there is not space in the original volume.

This book is evidently the result of much research and thought. The material is carefully chosen and well organized. The reviewer feels that many teachers of college geometry will choose this book as a text. He also feels that it should be found in the library of every teacher of high school geometry.

J. M. KINNEY

THE WORLD AND THE ATOM, by G. Møller and Ebbe Rasmussen. Cloth. 199 pages. 13.5×21.5 cm. 1940. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York, N. Y. Price $2.75.

Any physics teacher who has not been able to keep pace with the progress in nuclear physics will find in this little book an excellent answer to his wish. It is a brief review of the development in this field from its beginnings to the close of 1937. The authors divide this period into three main sections; namely, (1) from Becquerel and radioactivity in 1895 to Rutherford's discovery of the atomic nucleus in 1911, (2) from Bohr to quantum mechanics in 1926, (3) the period of nuclear physics from 1926 to the present.

The book is an attempt to translate for the public the researches on the atom, hence it is descriptive and narrative rather analytical. But those who attempt to read it without a background of considerable physical science will find it rather difficult to follow, especially through the second section which deals largely with theories of atomic structure. But as a first view of the field for science students and for teachers who completed their course work some years ago the book is especially valuable. The first section covering the discoveries and experiments of Becquerel, Thompson, Millikan, Rutherford and others has been well covered by many other authors and is fairly well known. The second section requires rather detailed knowledge of a large field for comprehension of the theories needed to ex-

plain and harmonize the great discoveries of the first period. No author, writing for the public, has ever succeeded very well in this field. This book gives some help but it will not satisfy popular demand. The third section deals with the questions now in the minds of teachers and students, and here the authors of this book have made their greatest contribution to science education. After recognition of the inability of the authors to fully reach the desired goal, one must conclude that they have produced one of the best short books in the field—a book worthy of a place in any library of science.

G. W. W.

HANDBOOK OF CHEMISTRY AND PHYSICS. Twenty-fifth Edition. Editor in Chief, Charles D. Hodgman, *Associate Professor of Physics in Case School of Applied Science;* Associate Editor, Harry N. Holmes, *Professor of Chemistry at Oberlin College.* Cloth. Pages xviii+2503. 11.5×18 cm. 1941. Chemical Rubber Publishing Company, 1900 West 112th Street, Cleveland, Ohio. Price $3.50 in United States, and $4.00 elsewhere.

The 1941–42 edition of the *Handbook* is now on sale. No doubt practically every reader of this journal is acquainted with one or more of the previous editions, hence we need mention only a few of the changes and additions. For the very rapidly growing group interested in meteorology there is a table converting pressures in inches and centimeters of mercury to millibars. The mathematical section now includes tables of secants and cosecants. The list of symbols and abbreviations has been revised following the recommendation of the American Association of Physics Teachers. Other changes include an important revision and enlargement of the section on amino acids; new data on plastics, vitamins, and isotopes; and additions to the sections on photographic plates and films.

G. W. W.

RADIO TROUBLESHOOTER'S HANDBOOK, by Alfred A. Ghirardi, Author, "The Radio Physics Course," "Modern Radio Servicing," and "Radio Field Service Data." Revised and Enlarged Second Edition. Cloth. Pages x+710. 20.5×25 cm. 1941. Radio & Technical Publishing Company, 45 Astor Place, New York, N. Y. Price $3.50.

Radio Troubleshooter's Handbook is the most important tool of the service man. But it is more than that. It is a valuable reference for all students and teachers of radio, and for all technicians, amateurs, and experimenters in the field. The new edition, some forty per cent larger than the original is more than one hundred per cent better. Between four and five thousand "case histories" of radio models have been compiled. These, covering home and auto receivers and record changers, make up about half the book. They are conveniently arranged with the most common symptoms of trouble and remedies listed. In addition there is plenty of help for general trouble shooting, complete tube data, descriptions of all standard parts and instruction for replacements, formulas, charts, graphs, tables, and finally complete lists of radio manufacturers, publishers, and schools. It is a marvel that any volume so elaborate and complete can be sold at the price listed. For the service man it is cheap at any price.

G. W. W.

Under the title of "The March of Medicine" the New York Academy of Medicine has been giving a series of lectures to the public. The lectures

have met with success. This has led to the publication of the lectures given in book form, following are comments on series V given during 1940 and series VI given during 1941.

The March of Medicine. Edited by the Committee on Lectures to the Laity of the New York Academy of Medicine. Cloth. 14×20.5 cm. Pages xii+154. Index. Columbia University Press. 1940. $2.00.

Series no. V has the following titles: I—The Inheritance of Mental Disease; II—Chemical Warfare against Disease; III—The Story of Our Knowledge of the Blood; IV—The Story of the Viruses; V—The Ascent from Bedlam; VI—The Romance of Bronchoscopy.

Series no. VI has the following titles: I—Humanism and Science; II—Paracelsus in the Light of Four Hundred Years; III—Psychiatry and the Normal Life; IV—Philosophy as Therapy; V—The Promise of Endocrinology; VI—What We Do Know about Cancer.

To most laymen the medical doctor is a man of mystery as far as the doctor's work is concerned. The doctor's work to a great degree is empirically scientific. The lay mind does not work that way. Medical truths, progress and history must be interpreted to him because he does not understand the doctor's language and methods. The New York Academy of Medicine has been attempting this interpretation for several years now, by giving a series of lectures during the calendar year. These lectures are given by men who are authorities in their respective medical fields. The lectures are so prepared and edited that nothing of scientific truth is omitted but yet may be understood by most average people. These lectures should break down any suspicion and superstition which might still be present in the minds of some of the laity, regarding the practice of medicine. To the teacher working in human biology here is something ready to hand, which otherwise might necessitate long hours of reading and assembly so that students might understand the material presented.

A. G. ZANDER

PRINCIPLES OF GENERAL CHEMISTRY, by Stuart R. Brinkley, *Associate Professor of Chemistry, Yale University*. Third Edition. Cloth. Pages x+703. illus. $23\frac{1}{2}\times15\frac{1}{2}$ cm. 1941. The Macmillan Co., 60 Fifth Ave., New York, N. Y. Price $4.00.

This edition of an excellent text for college students who have had a preparatory course in chemistry and who have a particular interest in the field, replaces the last revision which was published in 1933. The purpose of the book is still the same—"To present a different and a more advanced point of view with emphasis on the interpretation and significance of the scientific data, not merely the facts themselves."

The subject material has been revised and in many parts rewritten to give the best contemporary point of view. The order of presentation has been materially changed to allow an early discussion of the atomic and kinetic theory. Upon this foundation, the classification of the elements, chemical equilibrium, solutions, colloids, ionization and dependent topics have been built. The discussion of the non-metallic elements serves as a background to illustrate the interrelationship of these theories. The author has taken great pains to introduce modern concepts with clarity and sufficient detail to make the book adequate for the serious student. Interionic attraction, ionizing solvents, oxidation numbers, the Bronsted and Lowry definitions of acids and bases and the modern form of the Periodic Table serve as the basis for the development of the context of the book. The theoretical material is placed for the most part in the first half of the volume.

When the student reaches the account of the metals and electrolytes, it forms the subject matter for qualitative analysis which may be the laboratory work in the second semester of the inorganic course. The factual information has been arranged in very compact form. To illustrate this condensation, the metallurgy for all metals has been put together and the plan is introduced of discussing classes of salts together rather than individual metals and the compounds for each one. A new chapter has been introduced on the nucleus of the atom.

A sufficient number of industrial applications of chemistry have been added in order not to neglect the practical importance of the science. There are excellent references for further reading which develop the theoretical concepts beyond the scope of the text and give the superior student a valuable source of accurate information. A new feature is a set of problems. The appendix has been modified by deleting some tables of properties of elements and adding lists of electrode potentials, oxides and acids, oxidation and reduction equations, ionization constants and simple logarithm tables.

This book can be considered suitable only for students who have a fair grasp of chemistry and who are interested in the fundamentals. The word "Principles" in the title suggests the general character of this text.

VIRGINIA BARTOW
University of Illinois

PRACTICAL MATHEMATICS FOR SHIPFITTERS, by Louis Quentin Moss, *Special Assistant to the Principal, Jules E. Mastbaum Vocational School, Philadelphia, Pa.* Cloth. Pages xviii+108, 13.5×20.5 cm. 1941. Pitman Publishing Corporation, 2 West 45th St., New York, N. Y. Price, $1.50.

The author states in his preface "The current naval shipbuilding program had barely got under way when requests began to come in from various training organizations for a brief but practical book in mathematics for shipfitters and other shipyard workers. This volume is the answer to these numerous requests." The book was prepared with the co-operation of the management of the Philadelphia Navy Yard.

The teacher of geometry in academic high schools will find in this book an answer to the question, "What is this theorem used for?" in certain instances, as it shows how many theorems are applied in ship building and hence are now aiding us in national defense. Applications are shown for the construction problems of geometry, the Pythagorean theorem, theorems for proving angles equal, and areas of triangles, various quadrilaterals, circles, etc. The teacher of arithmetic will find applications of fractions and decimals. The book contains a glossary of shipyard terms, and many practice problems complete with the answers.

GLENN HEWITT
Von Steuben High School, Chicago, Ill.

SIX-PLACE TABLES, WITH EXPLANATORY NOTES, by Edward S. Allen, *Associate Professor of Mathematics, Iowa State College, Ames, Ia.* Cloth. Pages xxiii+181, 11×18 cm. 1941. McGraw-Hill Book Co., 330 West 42nd St., New York, N. Y. Price $1.50.

This is the sixth edition of this useful selection of tables, and includes by request three new tables not found in previous editions: six-place common logs of factorials of numbers from 1 to 100; a brief table of two complete elliptic integrals, K and E; and a four-place table of trigonometric functions of angles expressed in radians, together with their logs, for angles

from 0 to 3.20 radians. As in the previous editions, the book contains tables of square and cube roots; squares and cubes; circumferences, areas; reciprocals; fifth powers; decimal equivalents; common logarithms; four-place natural logs from 0.1 to 10; logs of trigonometric functions; natural trigonometric functions by minutes to 180°, includihg secant and cosecant tables; conversion tables; exponential and hyperbolic functions; gamma functions and probability integrals; table of integrals, etc. Pocket size, the book is printed with a handy marginal index for easy opening to any desired table.

GLENN HEWITT

ESSENTIALS OF SHOP MATHEMATICS, by Samuel Slade, *Administrative Assistant, New York Vocational High School*, and Louis Margolis, *Brooklyn High School for Metal Trades, City of New York*. Cloth. Pages viii+194. 13.5×20 cm. 1941. John Wiley and Sons, Inc., New York. Price, $1.50.

The purpose of this book is to provide a basic text in mathematics as applied to those trades in vocational schools which are most commonly taught —automobile mechanics, electric shop problems, machine shop practice, printing, sheet metal work and woodworking problems. The authors state that the book can be used as a basis for applied meathematics in trade or industrial schools either for short courses or for more extended and advanced work in courses covering two years or more. The format is attractive, and the binding and paper used are such that they will stand hard wear in the shops.

GLENN HEWITT

BOOKS AND PAMPHLETS RECEIVED

INTRODUCTORY ORGANIC CHEMISTRY, by E. Wertheim, *Professor of Organic Chemistry in the University of Arkansas*. Cloth. Pages vii+482. 15×23 cm. 1942. The Blakiston Company, 1012 Walnut Street, Philadelphia, Pa. Price $3.00.

SECOND-YEAR ALGEBRA, by Raleigh Schorling, *Head of Department of Mathematics, The University High School, and Professor of Education, University of Michigan;* Rolland R. Smith, *Specialist in Mathematics, Public Schools, Springfield, Massachusetts;* with the cooperation of John R. Clark, *Teachers College, Columbia University*. Cloth. Pages xii+484. 12.5×20.5 cm. 1942. World Book Company, Yonkers-on-Hudson, New York, N. Y. Price, $1.68.

PRINCIPLES OF MECHANICS, by J. L. Synge, *Professor of Applied Mathematics, University of Toronto*, and B. A. Griffith, *Lecturer in Applied Mathematics, University of Toronto*. First Edition. Cloth. Pages xii+514. 15×23 cm. 1942. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York, N. Y. Price $4.50.

A COLLEGE COURSE IN BUSINESS MATHEMATICS, by Henry Smithline, *Instructor in Business Mathematics, New Utrecht High School and School of Commerce, St. John's University, New York City;* Clyde O. Thompson, *Late Associate Principal, Mount Vernon, New York, High School and Supervisor of Commercial Education, Mount Vernon, New York*. Cloth. Pages ix+317. 14.5×23 cm. 1942. Prentice-Hall, Inc., 70 Fifth Avenue, New York, N. Y. Price Trade $1.40, school $1.05.

TO DISCOVER MATHEMATICS, by Gaylord M. Merriman, *Associate Professor of Mathematics, University of Cincinnati.* Cloth. Pages xi+435. 15×23 cm. 1942. John Wiley and Sons, Inc., 440 Fourth Avenue, New York, N. Y. Price $3.00.

CHEMISTRY, by Gerald Wendt, *Formerly Dean, School of Chemistry and Physics, The Pennsylvania State College.* Cloth. Pages ix+300. 13.5×21.5 cm. 1942. John Wiley and Sons, Inc., 440 Fourth Avenue, New York, N. Y. Price $1.75.

INTERMEDIATE ALGEBRA, by H. L. Rietz, *University of Iowa;* A. R. Crathorne, *University of Illinois;* and L. J. Adams, *Santa Monica Junior College.* Cloth. Pages vii+248. 1942. Henry Holt and Company, 257 Fourth Avenue, New York, N. Y. Price $1.75.

THE READING OF VERBAL MATERIAL IN NINTH GRADE ALGEBRA, by Margaret Grace McKin, Ph.D. *Teachers College, Columbia University.* Contributions to Education, No. 850. Cloth. Pages viii+133. 14.5×23 cm. 1941. Bureau of Publications, Teachers College, Columbia University. New York, N. Y. Price $2.10.

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*E. O. Bower
*Anna E. Burgess
*J. O. Collins
*Everett H. Hurlburt
*Ona Kraft
*Mary Melrose
*N. A. Neal
*Sister Celine SSJ
*Villa B. Smith
*W. N. Smith
*Alma Thomas
*A. L. Thompson

Columbus
*G. P. Cahoon
*O. E. Fink
Charles Goodwin
*Danna Whiting

Delaware
*C. W. Jarvis

Lorain
*Martin V. McGill

Massillon
*William Arva

Middletown
Arthur Assum

Oxford
*H. C. Christofferson
*J. S. Richardson

Uhricksville
*W. H. Barnes

WASHINGTON

Seattle
*George S. Wilson

WISCONSIN

Baraboo
*Eleanor H. Cox

Beaver Dam
William A. Lindeke
Mary McClintock
Charles A. Randall Jr.

Beloit
*Joseph W. Rhodes

Burlington
*Sister M. Padua
*Carl Treichel

Edgerton
*Truman G. Bloss
*Leman U. Rood

Fond du Lac
*Ellen M. O'Neil

Green Bay
*R. M. Russell

Kenosha
*Myrtle Creaser
Ethel Lewis
Henry C. Roscoe

Madison
*William A. Porter
*Ira Davis
*Milton O. Pella
*Paul Trump

Manitowoc
*Sister St. John Francis

Marshfield
Kenneth Boylan

Milwaukee
Fran M. Bruce Jr.
John Claude
*Claudia G. Fink
*Leonard B. Johnson
*Clyde H. Keenerick
*W. R. Leker
*W. F. Roecker
*Fred Schreiver
*Sister M. Ambrose
Sister M. DePazzi SSWD
*Sister M. Liguoria OSF
Sister M. Lucina
*Sister M. Mira
*Sister M. Mirabella
*Sister M. Sebaldus
Sister M. Stanisia

Oshkosh
*J. O. Frank

Racine
*M. A. Potter

Sheboygan
*George K. Peterson
*L. D. Stoll

South Milwaukee
*Melvin Hintz
*McKenzie

Slinger
*Ralph Schultz
St. Francis
*Sister M. Nila
*Sister Leola
Superior
*Sister M. Winifred
Waterton
*Mark Anderson
Wausau
*Ben Berg
*E. A. Roeske
West Allis
Irene Kennert
*Pauline Royt
*Mabel E. Dittman
*Sidney Hambling
*Monroe Heuer
*R. Wallace O'Neill
*M. J. W. Phillips
*H. R. Stamm
Williams Bay
*Carl Enger
Winona
*Sister M. Eone

COOPERATIVE CHEMISTRY TESTS

The Committee of Examinations and Tests, Division of Chemical Education, of the American Chemical Society, has announced that the 1942 Cooperative Chemistry Test will be available by April first. Inquiries should be addressed to the Cooperative Test Service, 15 Amsterdam Avenue, New York City.

The accumulation of data and experience of the past six years has had the effect of modifying the concept of what a test should measure and how this should be accomplished. As a result of extensive discussion at a conference, held at the University of Chicago last June, the 1942 Form of the test is considerably different from the tests of the past four years. The test has been administered in a preliminary form to determine the difficulty and validity of each item. The committee hopes for wide-spread adoption of this new test, a brief description of which follows.

1942 Cooperative Chemistry Test

Part I. General Knowledge and Information.

This section is based on knowledge of or *acquaintance with* important facts, definitions, laws and theories of chemistry. Historical events and application of chemistry to the social and economic world are represented.

Part II. Application of Principles.

This part attempts to measure the ability to solve numerical problems, to balance equations and to make quantitative predictions by the application of chemical principles.

Part III. Scientific Method.

This section is concerned with the understanding of the relation of observation, definitions, laws, theories in the scientific procedure. The relation to theory to experiment is represented, as well as the ability to interpret chemical data.

Part IV. Knowledge of Laboratory Technic and Procedure.

This new section is included in the effort to measure acquaintance with the laboratory and knowledge of "correct" procedures. It does not attempt to measure skill or technic *per se*.

The committee which is sponsoring this test is comprised of the following members of the Division of Chemical Education:

B. Clifford Hendricks, University of Nebraska
Rufus D. Read, New Jersey State Teachers College
Ed. F. Degering, Purdue University
Laurence S. Foster, Brown University
Earl W. Phelan, Georgia State Womans College
Theodore A. Ashford, University of Chicago
Otto M. Smith, Oklahoma A and M College, *Chairman*